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# OIL SKIMMING DEVICES

Edison Water Quality Laboratory
New Jersey

May 1970

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CLEAN WATER

Edison Water Quality Laboratory

May 1970

# OIL SKIMMING DEVICES

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## INTRODUCTION

Oil pollution constitutes a problem which is becoming of great concern to the people of all nations. The contamination of coastal and inland waters presents not only a hazard of fire, which threatens human life and property, but interference with the recreational and aesthetic use of these waters, as well as a menace of ill-defined proportions to waterfowl and aquatic and marine life.

The best possible answer to the problem other than the unlikely complete elimination of oil pollution is to recover the oils before they do damage. There are a number of methods available to accomplish this, among which are the use of mechanical devices known as "skimmers" to recover oil from the water surface. This type of apparatus attempts to physically remove the oil by means of weirs, slotted pipes, suction or vacuum devices, and continuous drum and belt adsorbers.

This document describes a number of different oil collection devices presently available, giving the manufacturer's name and other pertinent information on each method. In addition, some information covered by various patents on the subject of skimmers is also included.

The skimming devices described in this report consist primarily of three different types: weir, drum and belt. The skimmers are classified as belonging to one of the major categories. The weir type uses the principle of overflowing a weir to separate the oil from the surrounding water,

whereas the belt and drum types utilize the principle of selective adsorption of the oil from the water.

In each category, skimmers have been listed in alphabetical order. The Federal Water Quality Administration in no way endorses or recommends any of the oil skimming equipment or devices mentioned in this report.

We have made no attempt to determine the relative effectiveness of any of the skimming methods or to compare their merits. The equipment is described in as much detail as practicable from the information available. Additional data can be secured from the reference indicated, or by contacting the manufacturer or inventor directly.

We recognize that several skimming devices or techniques may have been omitted simply because our office has not received information concerning them. For this reason, this report should be used as a basic guide and reference for skimming devices. As information on new equipment is received, it will be added to this report, while obsolete devices and techniques will be deleted. We hope that the dissemination of information contained in this report will stimulate new ideas and commercial development of devices to control oil pollution, as well as familiarize potential users with various types available.

A summary table presenting pertinent information concerning all of the skimmers discussed in the body of the document follows this foreword.

## S K I M M E R S

### SUMMARY TABLE

| Name | State of Development | Location Where Information is Available |
|---|---|---|
| 1. Earle System | In production | Surface Separator Systems, Inc.<br>103 Mellon Avenue<br>Baltimore, Md. 21228 |
| 2. Earle Non-propelled Skimmer | In production | Surface Separator Systems, Inc.<br>103 Mellon Avenue<br>Baltimore, Md. 21228 |
| 3. Floating Disc Type Oil Recovery Unit | In production | Centri-Spray Corporation<br>39001 Schoolcraft Road<br>Livonia, Mich. 48150 |
| 4. Mop-Cat | In production | The Worthington Corporation<br>Pioneer Products Division<br>P. O. Box 211<br>Livingston, N. J. 07039 |
| 5. Reclam-Ator | In production | Welles Products Corporation<br>Roscoe, Illinois 61703 |
| 6. Belt Skimmer | Under patent | Friedbert Grabbe<br>Oelberg 21<br>Essen-Katernberg, Germany |

| Name | State of Development | Location Where Information is Available |
|---|---|---|
| 7. Brill Skimmer | In production | Oil Skimmers, Inc.<br>Cleveland, Ohio 45213 |
| 8. British Petroleum Corp. Skimmer | Under patent | British Petroleum Corp.<br>London, England |
| 9. Centri-Spray Oil Recovery Unit | In production | Centri-Spray Corporation<br>39001 Schoolcraft Road<br>Livonia, Mich. 48150 |
| 10. Craft for Removing Oil Films | Under patent | Edward J. Lane<br>British Petroleum Company, Ltd.<br>London, England |
| 11. Harmstorf Skimmer | In production | Harmstorf Corporation<br>446 West 34 Street<br>New York, New York 10001 |
| 12. Mutton-Cloth Roll Skimmer | Unknown | Oswald Hardie<br>Port of Manchester<br>England |
| 13. Oil-Evator | In production | Bennett International Services<br>302 A-5645 Topanga Canyon Blvd.<br>Woodland Hills, Calif. 91364 |
| 14. Rex Chainbelt Inc. Skimmer | In production | Rex Chainbelt, Inc.<br>Milwaukee, Wisc. 53201 |

| Name | State of Development | Location Where Information is Available |
|---|---|---|
| 15. Selective Separation of Oil from Water | Under patent | Esso Research & Engineering Co.<br>Florham Park, N. J. 07036 |
| 16. Sewell Belt Skimmer | Under patent | Richard H. Sewell<br>Victoria<br>British Columbia, Canada |
| 17. The Murphy Pacific Marine Salvage Company Skimmer | Prototype | U. S. Navy Base<br>San Francisco, Calif. 94102 |
| 18. Dunlop-Dracone Skimmer | Prototype | Dunlop-Dracone Consortium<br>London, England |
| 19. Floating Oil Skimmer | In production | Rheinwerft Gesellschaft<br>Mainz-Mornbach, Germany |
| 20. Floating Saucer - Water and Sludge Pump | In production | International Marketing Agents<br>P. O. Box 95062<br>Oklahoma City, Okla. 73109 |
| 21. Futaba | In production | Hikari Industries Corp.<br>Japan |
| 22. Liquid Surface Skimming Device | Under patent | Esso Research & Engineering Co.<br>Florham Park, N. J. 07036 |
| 23. Norfolk Skimmer | Prototype | H. W. Lee<br>Norfolk Naval Shipyard<br>Norfolk, Va. 23511 |

| Name | State of Development | Location Where Information is Available |
|---|---|---|
| 24. Perforated Baffle Skimmer | Under patent | Patent Office<br>Ontario, Canada |
| 25. Pipe Skimmer | Under patent | Jacques Muller<br>La Garenne<br>Colombes, France |
| 26. Sea Broom | In production | Sunshine Chemical Company<br>P. O. Box 5534<br>Jacksonville, Fla. 32207 |
| 27. Sea Sweep | Under development | Core Laboratories<br>P. O. Box 10185<br>Dallas, Texas 75207 |
| 28. Skimmer for Removing Oil Layers from Water Surfaces | Under patent | Georg Shuback<br>Hamberg, Germany |
| 29. Technocean Skimmer | 1 Model made up | Technocean Corporation<br>45, Boulevard Haussmann<br>75 - Paris, France |
| 30. "T-T" Skimmer | In production | East Coast Services Inc.<br>Braintree, Mass. 02203 |
| 31. Univac Pump Skimmer | In production | Henry Sykes Ltd.<br>530 Southwork Street<br>London, England |

| Name | State of Development | Location Where Information is Available |
|---|---|---|
| 32. Verolme Harbor Cleaner | In production | Verolme Shipyard Hensden Ltd.<br>Verolme United Shipyards<br>Rotterdam, Netherlands |
| 33. "Waterwisser" | Prototype | Holland Launch N. V.<br>Zaandam, Netherlands |
| 34. Air Broom | Under patent | Hall, Rademacher and Biglane<br>FWQA<br>Washington, D. C. 20242 |
| 35. BUDA-1 | In production | Marine Pollution Control Corp.<br>9010 Roselawn Avenue<br>Detroit, Mich. 48204 |
| 36. Vacuum Trucks | In production | Most Tank Cleaning Service Companies |

## DESCRIPTION

### DRUM TYPE SKIMMERS

These types of oil skimming devices use a rotating drum or cylinder covered with an oil absorbent material to absorb the oil from an oil and water mixture. These surfaces are generally hydrophobic and oleophilic (they are not wetted by water but are by oil). The drum surfaces used to date generally have been constructed either of aluminum or polyurethane. The oil is squeezed or scraped off the surface of the drum by a knife blade or by rollers and then is segregated from the water.

In the case where the drum has an aluminum surface, the best recovery rates have been achieved with higher viscosity oils. On the other hand, polyurethane coated drums have worked best for low viscosity oils which are non-weathered, since these oils can be absorbed more rapidly by the polyurethane.

The effectiveness of drum type skimmers has been reported to be reduced when the oil film thickness is less than 1/4 of an inch[1]. Because of this inefficiency, some method is required to concentrate the oil by some type of dynamic booming or some other means.

The Standard Oil Company[2] of New Jersey has reported that:

> "The efficiency of recovery is dependent on the thickness of oil, viscosity of the oil, affinity of the drum's surface for oil, rate of cycling of the drum, and the velocity of the recovery vessel on which the

> cycling drum is installed. The velocity of the skimming vessel is important since a critical velocity exists above which a hydraulic jump will form in the oil along an arc ahead of the skimming vessel. This causes oil to escape around the end of the booms which are used to concentrate the oil as the vessel moves through the water. The angle between the booms is another important factor. If the angle is too large, oil tends to pile up at the boom and not move along the boom to the skimmer. The rate of cycling of the drum is important since water is picked up by the element if its speed of rotation is too great".

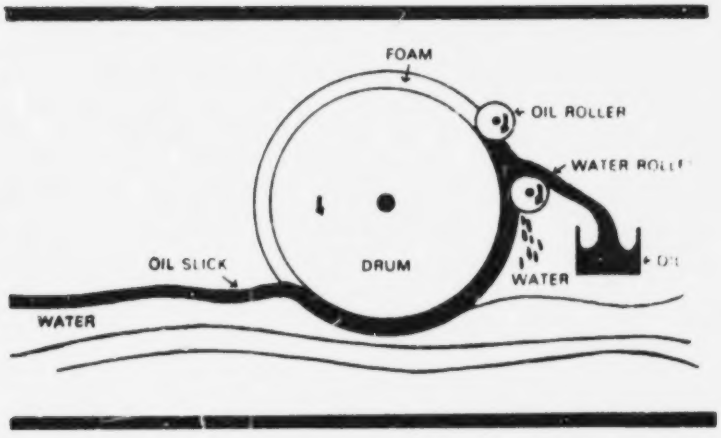
Under open sea conditions, or when waves are over two feet in height, the oil film layer comes in contact with the drum at varying rates. This action reduces pickup efficiencies (highest recovered oil/entrained water ratio) drastically. Therefore, to date, drum type oil skimmers have been limited to use in calm or mild sea conditions.

---

Combating Pollution Created by Oil Spills, by A. D. Little, Inc., June 1969, for U. S. Coast Guard, Dept. of Transportation, Vol. 1, Methods.

Oil Spill Cleanup Manual, prepared by Oil Spill Task Force, Standard Oil Co. (New Jersey), Logistics Department, 1969.

SCHEMATIC OF A TYPICAL DRUM TYPE SKIMMER




Hydrophobic foam, mounted on rotating drum, gives Reclam-Ator up to 2,100 gallons per hour oil recovery capacity. Foam repels water, trace amounts of which are removed by low-pressure roller. Concentrated oil is squeezed out by second roller applying heavier pressure

Taken from product bulletin, Welles Product Corporation, Roscoe, Illinois, 61073

FIGURE I

## EARLE SKIMMER (DRUM TYPE)

This skimmer consists of two cylinders operating in series and attendant other equipment. The leading cylinder operates at a relatively high speed and serves to collect the oil film and concentrate it in a sump of which the cylinder itself forms one side. The considerable amount of water separates out within the sump.

The secondary cylinder operating at a lower speed, or intermittently in the thicker layer of oil, lifts the oil to an upper level where it is recovered in a trough from which it is pumped or spilled by gravity to a storage tank.

Since the storage tank is an integral part of a buoyant recovery apparatus, it is arranged to operate on the hydraulic displacement system i. e., it is always full of water, oil or a combination thereof. This obviates any significant changes in draft of the unit.

The cylinders are normally driven by hydraulic gearmotors. The prime mover for the hydraulic system may be a gasoline or diesel engine.

Modifications of stock designs may be developed to suit varying applications.

The cost of a 38'-6" barge pictured here is $105,000 f.o.b. Baltimore. Delivery can be effected in about six months.



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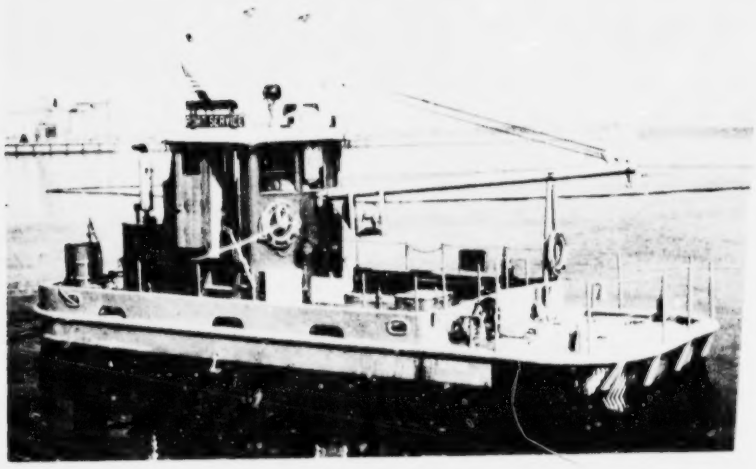
The Earle Skimmer can be obtained from:

Surface Separator Systems
103 Mellor Avenue
Baltimore, Maryland 21228



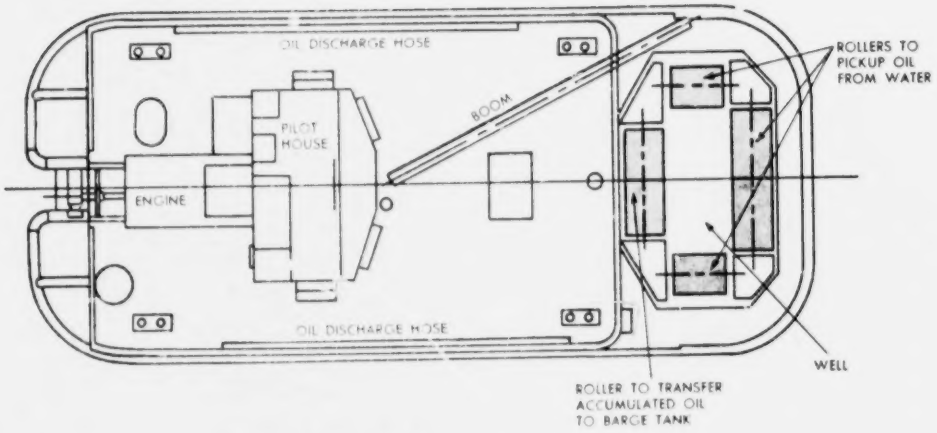



FIGURE 2 EARLE SKIMMER

Sales Bulletin - Surface Separator Systems, 103 Mellor Avenue, Baltimore, Maryland 21228.

EARLE

NON-PROPELLED SKIMMER

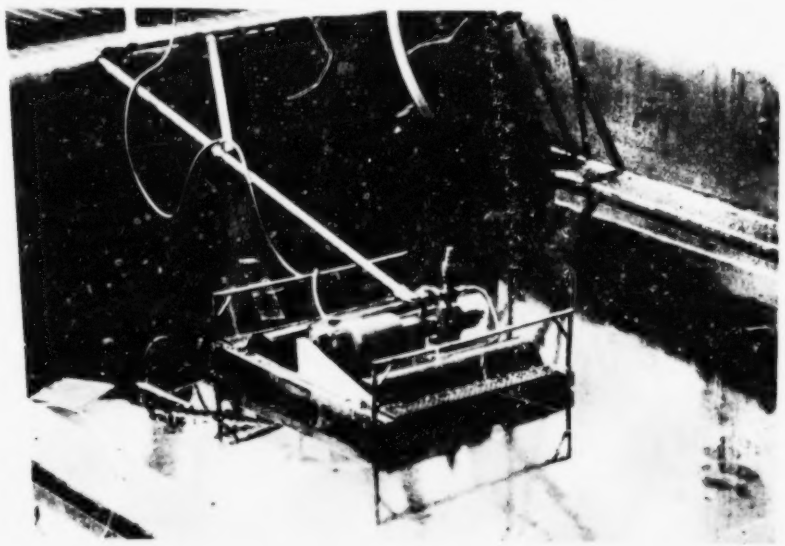
SURFACE SEPARATOR SYSTEMS, INC.

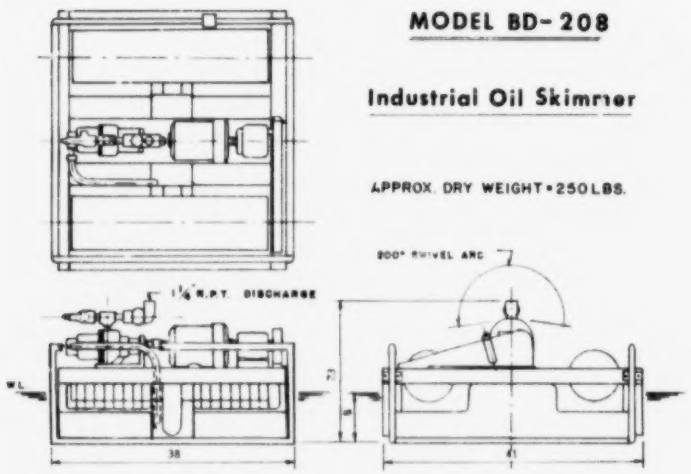
(Drum Type)

This unit is intended to be used in the recovery of persistent oil slicks in separators, lagoons and drainage basins where there is a continuous inflow of oily waste. This oil recovery device is a three cylinder hydraulic powered unit which recovers, separates and stores the oil in one continuous and combined operation. The oil film recovery mechanism is mounted on top of a 300 U. S. gallon oil storage tank. The buoyancy of both sections is such as to support the combined system at the proper operating draft. The oil recovery rate, when handling Bunker "C", is about 600 gallons of 95% pure oil-per-hour. Wave heights up to nine inches, wind, and rain are claimed to have practically no effect on the rate of retrieval. The recovered oil is delivered to the storage tank by gravity. To avoid significant changes in draft, this tank operates on a hydraulic displacement system i. e., it will always be full of water, oil, or a combination thereof.

The prime mover for the power pack may be an electric motor, air motor, diesel engine or gasoline engine. In locations where very infrequent oil spills occur and where auxiliary marine equipment is available, this model may serve for emergency use; otherwise, the self-propelled unit should be used.

This unit may be obtained from Surface Separator Systems, Inc., 103 Mellor Avenue, Baltimore, Maryland 21228.






Sales Bulletin - Surface Separator Systems, Inc., 103 Mellor Avenue, Baltimore, Maryland 21228.

FIGURE 3 FLOATING DISC TYPE OIL RECOVERY UNIT

## FLOATING DISC TYPE OIL RECOVERY UNIT

(Modified Drum Type)

Centri-Spray Corporation has recently developed a multi-disc oil recovery device. It is capable of removing 350 gallons per hour of 500 SSU oil at 70°F. Surface floating oil adheres to the continuously rotating multi-disc assembly.

Scrapers remove the oil which is deposited in a self-contained oil storage tank. A sump pump transfers the oil from the skimmer tank to a permanently located storage tank.

The unit generally contains 12, 24" diameter discs, 6 on each end. Other sizes are available, ranging from a single disc stationary mounted unit through any number of multi-disc units.

This unit can be obtained from:

Centri-Spray Corporation
39001 Schoolcraft Road
Livonia, Michigan 48150

---

Sales Bulletin from Centri-Spray Corporation, 39001 Schoolcraft Road, Livonia, Michigan 48150 obtained in December 1969.

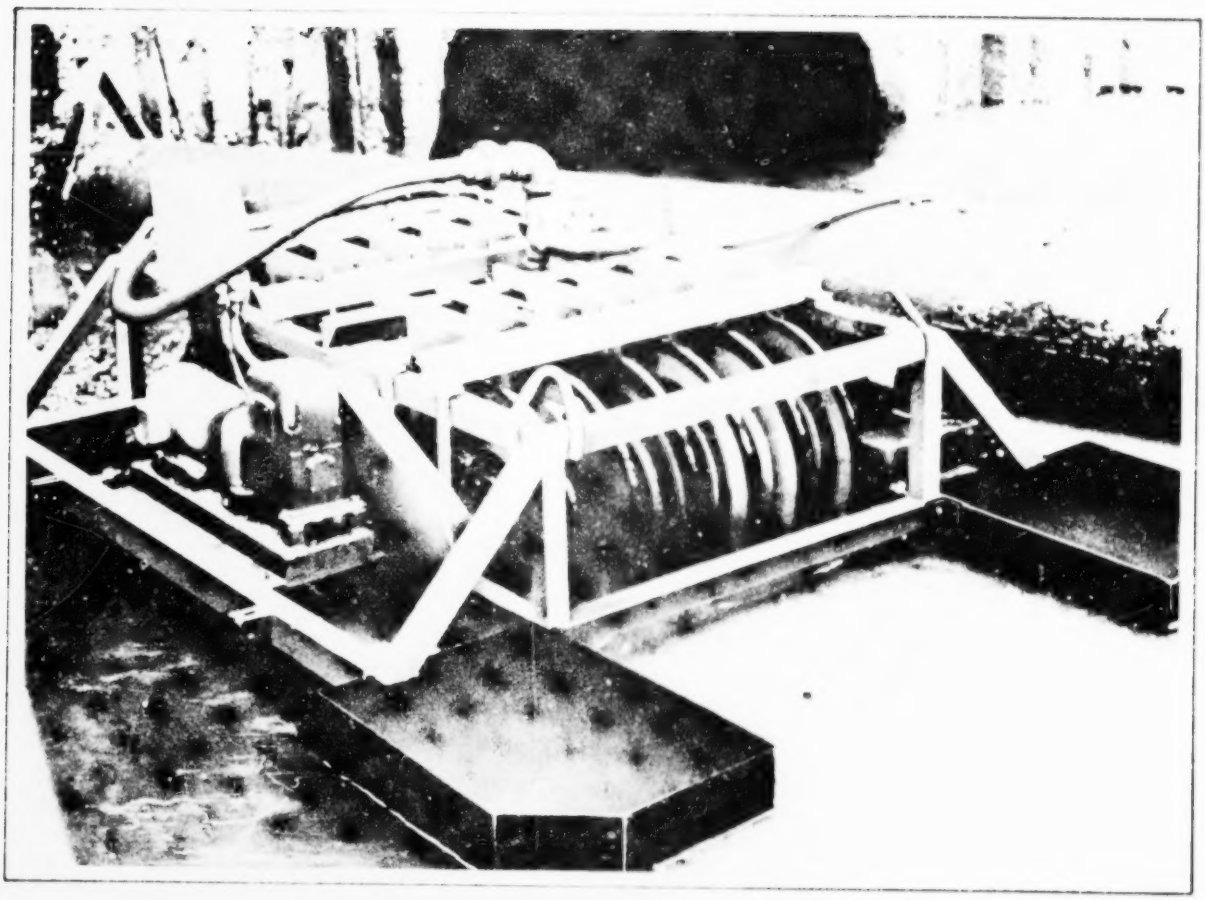


FIGURE 4. FLOATING DEBRIS/OIL RECOVERY UNIT

## MOP-CAT

## W.T.K.W. MARK I WORTHINGTON CORPORATION SKIMMER

(Drum Type)

The "Mop-Cat" oil recovery system is rated at 20 to 40 barrels per hour depending on the viscosity of the oil and sea conditions. It is designed and manufactured under a license from the Standard Oil Company of Indiana (see Reclam-Ator). The recovered oil is held in a 100 gallon retention tank, then pumped into drums on the deck or to floating bags towed alongside.

The basic platform of the catamaran boat consists of two solid filled hulls, 25 feet long, which maintain buoyancy. The boat has been designed with sufficient structural strength to permit it to be transportable by helicopter. The beam is 21 feet. At the box, two bow wings, approximately six feet long, are mounted at 45° with the keel line to provide up to 18 feet wide oil slick recovery swath. The bow wings are manually retracted, but provision is made for hydraulic operation. The intake for the oil recovery system is protected from debris by screens.

The prototype for this skimmer has been engineered and constructed and was tested in the New York area in the Fall of 1969.

The Mop-Cat is supplied by:

The Worthington Corporation
Pioneer Products Division
P. O. Box 211
Livingston, New Jersey 07039

---

Sales Bulletin - Worthington Corporation, Pioneer Products Division, P. O. Box 211, Livingston, New Jersey 07039

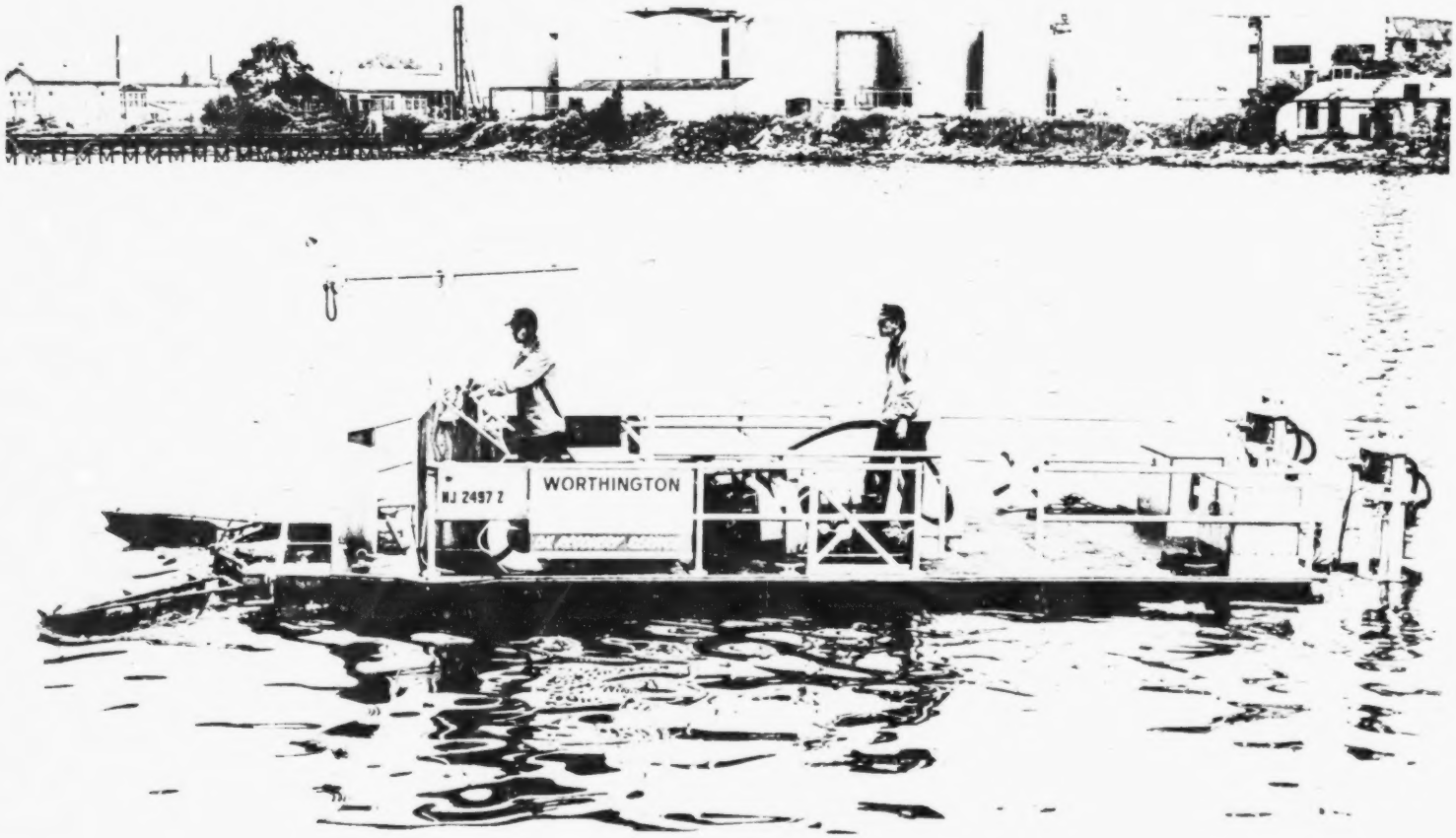



FIGURE 5 MOP-CAT OIL SKIMMER

## RECLAM-ATOR

## AMERICAN OIL CO. FLOATING SKIMMERS

(Drum Type)

A catamarian oil skimmer developed by American Oil Company's Research and Development at Whiting, Indiana, recovers oil spills from water. The skimmer is used to remove oil slicks from surface water in and around the company's refineries.

A single polyurethane-covered drum rotates continuously in the water while absorbed oil and water are squeezed from the foam by metal rollers. A low pressure roller removes the water before the drum rotates under the oil removing roller where greater pressure is exerted.

The rotating drum is 12 inches in diameter and 4 feet long. It is mounted on a commercially available pontoon catamarian 24 feet long and 8 feet wide. These dimensions permit the unit to be transported by commercial air, rail or highway vehicles. Average grade Bunker C can be recovered at rates up to 50 barrels per hour at 21°C.

Several more of these skimmers are being built by American and will be kept in readiness at the company's major marine terminals.

The Reclam-Ator can be obtained from:

Welles Products Corporation
Roscoe, Illinois 61073

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Sales Bulletin - Prepared by American Oil Company, Research and Development Department, Whiting, Indiana 46394. Also, Welles Products Corporation, Roscoe, Illinois 61073.

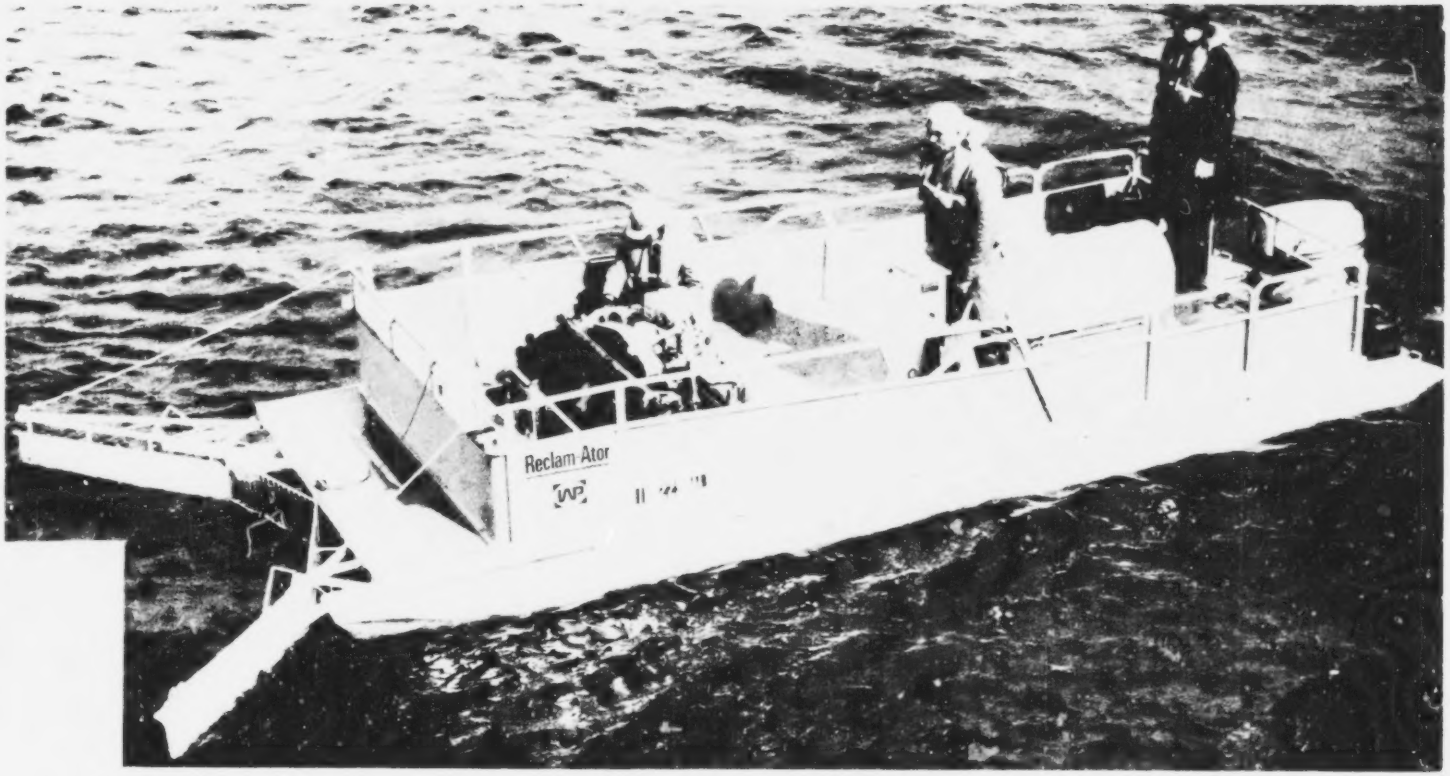


FIGURE 6 RECLAM-ATOR OIL SKIMMER

## DESCRIPTION

### BELT TYPE SKIMMERS

This type of oil skimmer utilizes an oil absorbent surface in a continuous belt to absorb the oil from an oil and water mixture. The belt carries the oil to the top of the belt mechanism where a blade or similar piece of equipment squeezes the oil from the belt before recycling. The belt is supported normally on two drums: one to submerge the belt in the oil and water mixture, and the other out of the mixture where the removal of the oil takes place.

A variety of materials has been used as the cycling belt on the endless belt type skimmers. These materials include specially treated fibers to make them hydrophobic; fine mesh wire screen; rubberized fabric; absorbent cloth; and resilient foam.

The belt type skimmers have many of the inherent problems previously discussed concerning the drum type skimmers. Belt type skimming devices are generally limited to calm waters and where oil films are of considerable thicknesses.

---

Combating Pollution Created by Oil Spills, by A. D. Little, Inc., June 1969, for U. S. Coast Guard, Dept. of Transportation, Vol. 1, Methods.

Oil Spill Cleanup Manual, prepared by Oil Spill Task Force, Standard Oil Task Force, Standard Oil Co. (New Jersey), Logistics Department, 1968.

SCHEMATIC OF TYPICAL BELT TYPE SKIMMER

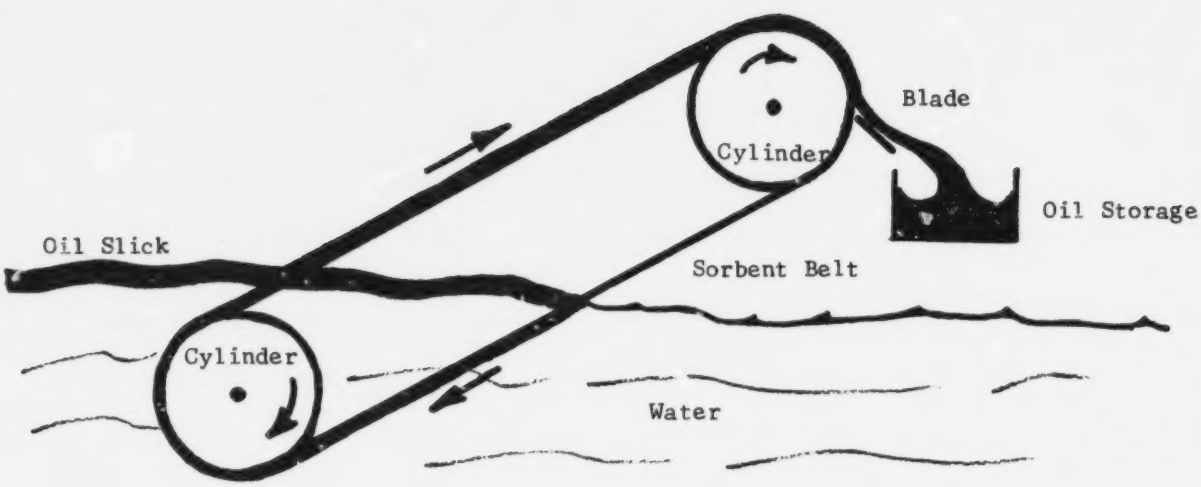


FIGURE 7

## BELT SKIMMER - GERMANY

(Belt Type)

The skimmer is described in a patent application #3,314,545, dated April 18, 1967. It covers a method of cleaning a water surface by removing oil and other similar floating impurities via an endless conveyor belt, which is made of material-like polyvinyl chloride to which oil sticks. The bottom rim of the belt extends downwards at an inclination to and through the water surface, and in the direction of the flow. The belt is driven so that it moves down along the bottom run and picks up oil as it passes through the oil film surface. The belt then passes around a roller which is immersed within the water and up along an upper run to a cleaning station. The cleaner is formed of comb-like scrapers which scrape oil from bands adjacent to the upper roller and discharge the oil into a collecting tank.

It has been found in practical tests that the oil impurities picked up by the apparatus can be removed from the surface of the water in a single working step and that only small proportions of water are picked up together with the oil. Reportedly, another advantage is that the apparatus is light in weight and can be produced at relatively low cost.

More information of this patent can be obtained from:

Friedbert Grabbe
Oelberg 21,
Essen-Katernberg
Germany

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Patent #3,314,545. Issued to Friedbert Grabble, Essen, Germany, dated April 18, 1967.

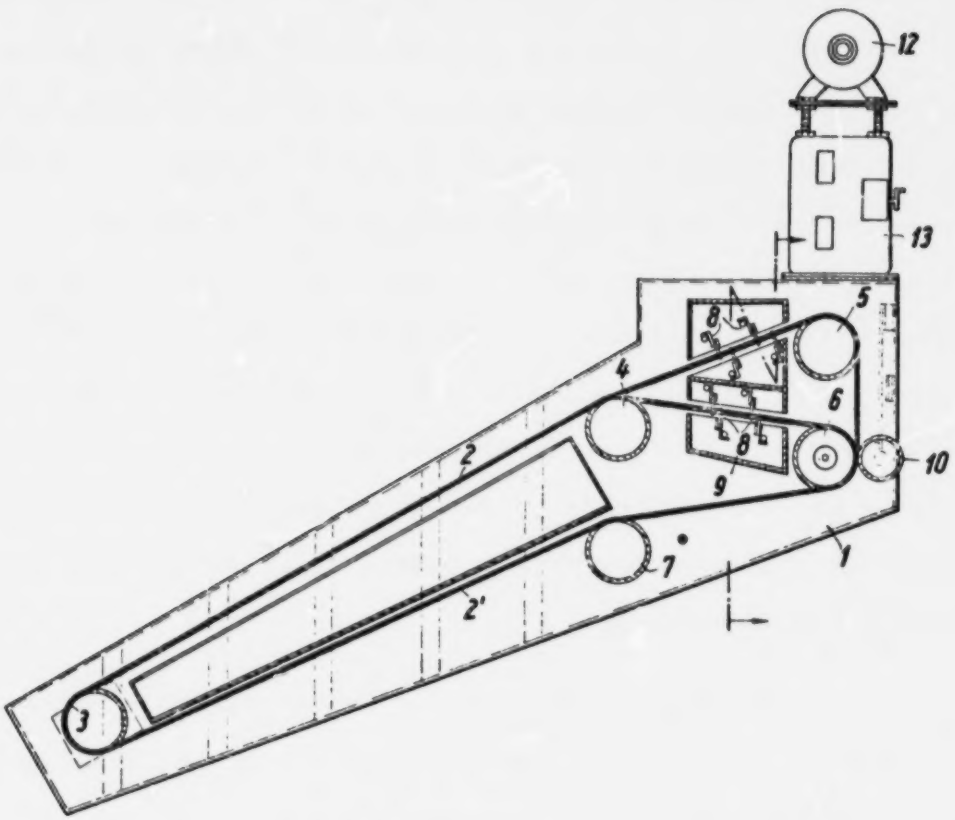


FIGURE 8 BELT SKIMMER - GRABBE

## BRILL SKIMMER

(Belt Type)

This skimmer includes a long tube as a belt over a sprocket and past a cleaning point where the oil is scraped off and flows to a container. The tubular belt is made of an oil absorbent material and is long enough to wind about the oil water surface. The oil is absorbed as the belt leaves the oil water surface. The tubular belt is small enough in diameter so that debris on the oil-water surface does not interfere with the operation. The sprocket handling the tubular belt is driven by an electric motor.

Information on the Brill Skimmer can be obtained from:

Oil Skimmers, Inc.
Cleveland, Ohio 45226

---

Drawings of typical skimmer prepared by Oil Skimmers, Inc.

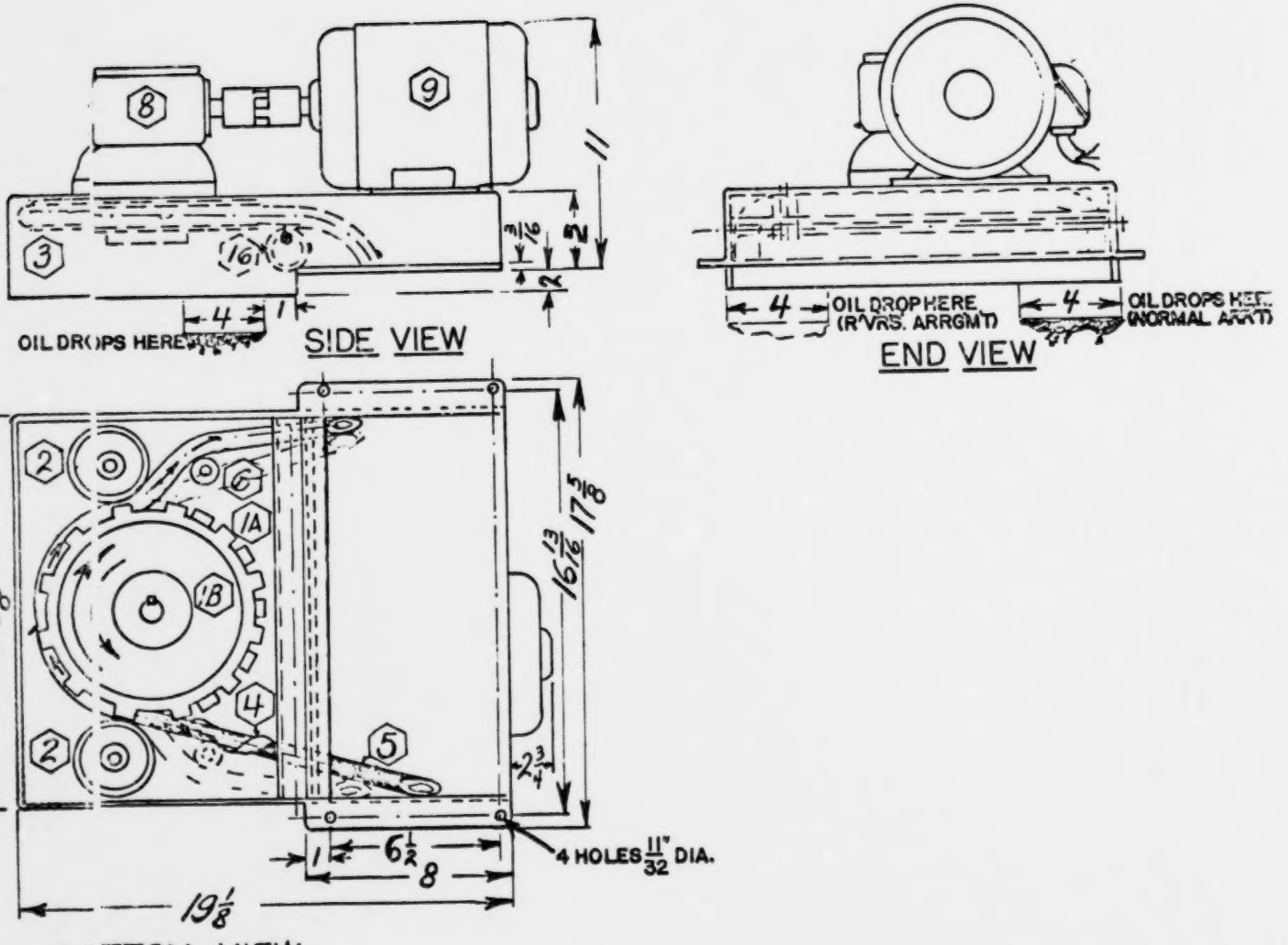


FIGURE 9 BRILL SKIMMER

## BRITISH PETROLEUM CO. - SKIMMER

(Belt Type)

This patent #1,026,201, dated April 14, 1966, covers a method of separating oil from water. The device comprises an endless belt of resilient foam material, several rollers between which the belt passes at its upper end, and means for collecting and removing liquid squeezed from the strip by the rollers. The resilient foam material is comprised of a number of inter-connected pores and is compressible so as to enable a liquid contained in the pores to be removed. A suitable material is a plastic foam such as polyurethane foam. The compression may be in the form of one or more pairs of rollers between which the resilient foam material is arranged to pass. The rollers may comprise the means for driving the endless band of resilient foam material.

Additional information on this belt type skimmer can be obtained from:

British Petroleum Co.
London, England

---

Patent Specification #1,026,201, published April 14, 1966, issued to the British Petroleum Co.

1026201 PROVISIONAL SPECIFICATION
1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

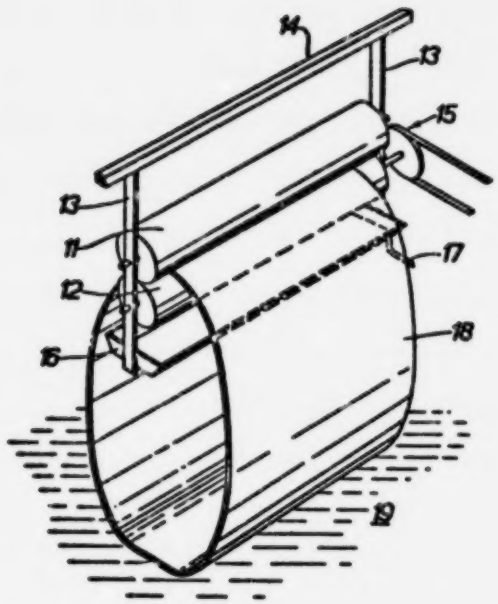


FIGURE 10 BRITISH PETROLEUM CO. SKIMMER PATENT

## CENTRI-SPRAY OIL RECOVERY UNIT

(Belt Type)

This unit is a belt skimmer driven by a one-horsepower motor linked through a speed reducer which drives an upper pulley which rotates the endless belt. The belt is dangled in the water and held tight by a lower pulley. As the belt is rotated through the water, the surface oils adhere to the belt and are drawn up over the top pulley. The oil is scraped off the belt by a set of wipers just below the top pulley and directed into a trough. The belt width is normally 24 inches and the scrapers are of plastic to reduce belt wear. There is some carry-up of floating debris such as straw. The oil from the belts usually contains less than 5% water. These units are available in capacities from 30 gallons-per-hour to 120 gallons-per-hour with belt widths ranging from 12 inches to 24 inches. The units are designed for sustained performance under continuous operating conditions. These units may be installed in rivers, lagoons, and need only connection to electrical power for immediate operation.

These oil recovery units can be installed in weather-proof housings equipped with infra-red or steam heating devices, to permit year around operation at below freezing temperatures. The units can be purchased from:

Centri-Spray Corporation
39001 Schoolcraft Road
Livonia, Michigan 48150

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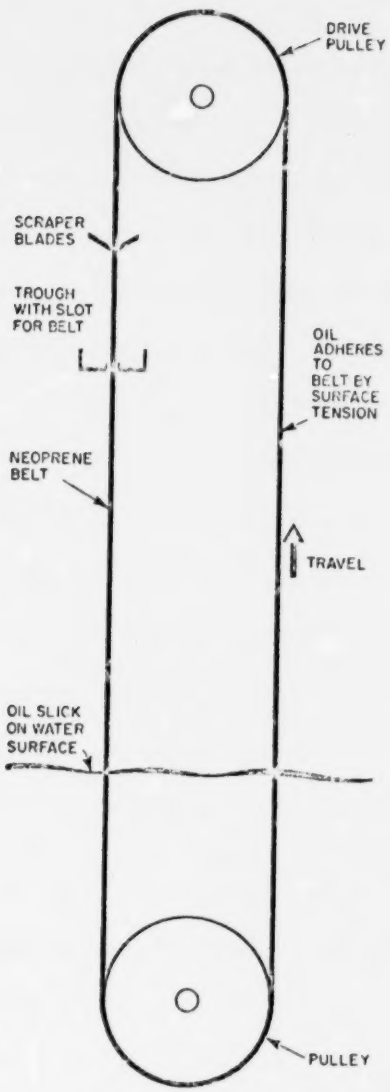
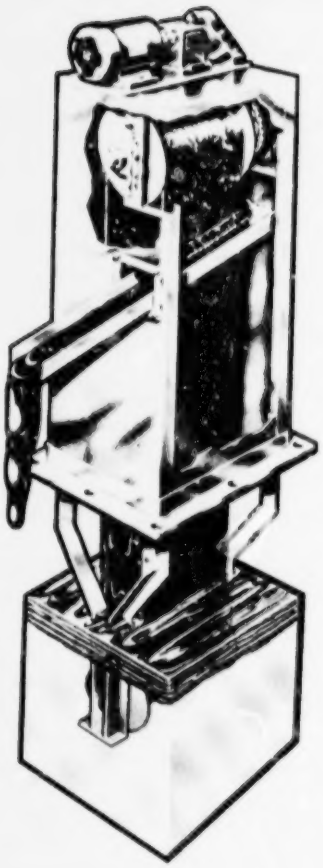
Sales Bulletin - Centri-Spray Corporation, 39001 Schoolcraft Road, Livonia, Michigan 48150.



*As belt rotates, surface oil adheres. The oil is scraped off by wipers below top pulley into trough where it is screened and dumped into steam heated tank.*

FIGURE 11 CENTRI-SPRAY OIL RECOVERY UNIT

## CRAFT FOR REMOVING OIL FILMS - ENGLAND

(Belt Type)

This skimmer is covered by Canadian Patent #712817, issued July 3, 1963, to Edward J. Lane of London, England. He later received and assigned U. S. Patent #3,314,540 to the British Petroleum Company, Ltd. The invention includes a device to cover oil pick-up and transfer, and a receptacle for the transferred oil, comprising a craft, the base of the receptacle being at least partially open to the water. The oil pick-up and transfer member is comprised of an endless belt. The belt being supported by two cylinders arranged so that when the craft is afloat, one cylinder will be at least partially immersed in the water, and the other cylinder can be mounted aboard the craft.

The receptacle preferably comprises the craft itself and the base of the craft may be entirely open to the water so that, in effect, the craft becomes a floating boom. Since the craft is open at the base, it will, of course, be necessary to maintain the craft afloat; for example, by buoyancy tanks. In the case of this invention, the liquid level inside the craft is maintained at a similar level to the water level outside. As oil is transferred via the belt into the craft, water is displaced through the base of the craft. The displacement of water in this manner allows a greater quantity of water to be accumulated in the device than in the normal type of collecting barge which is not open to the water. The actual material of the belt may be chosen from a variety of materials. One

example being a woven cotton fabric coated with neoprene. It has been found that better oil transference is obtained by driving the belt so that oil is carried downwardly through the water than by driving the belt in the other direction. The belt is also provided with a suitable device to remove any oil from the belt and to direct this oil into the craft for storage. This device is a scraper or a roller at the top of the craft.

Preferably, the belt will be mounted in two cylinders. For example, a belt driving cylinder and a belt idler cylinder. The driving cylinder may be mounted on a shaft, supported by brackets, fixed in the bow of the craft and the shaft may be driven by any suitable means, for example, a diesel engine.

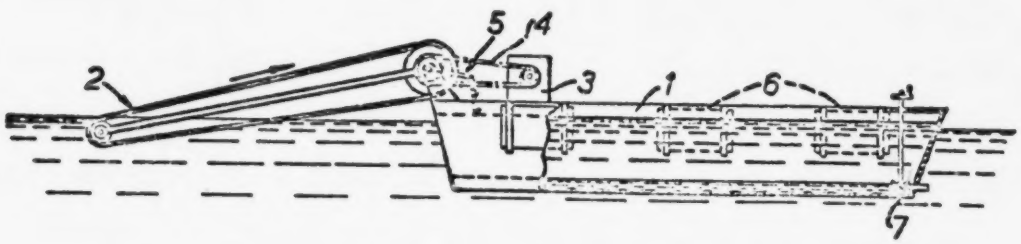



FIGURE 12 CRAFT FOR REMOVING OIL FILMS

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Canadian Patent #712817. Issued July 6, 1965 to Edward J. Lane, London, England. Granted to the British Petroleum Company, Ltd., London, England. U. S. Patent #3,314,540.

## HARMSTORF SKIMMER

(Belt Type)

The self-propelled oil recovery vessel is an advanced development of the Harmstorf floating oil skimmer. It consists of a hydraulic-powered steel open boat, fitted with a belt skimmer, slop collection tanks and transfer pump. It can be maneuvered through an oil spill at variable speed skimming and collecting the surface oil as it moves.

The vessel is powered by a 22-horsepower diesel engine powering three hydraulic motors; one motor drives the variable speed propeller which is rotatable through 360° and hence, provides steering and direction. A second motor drives the roller of the belt skimmer. A third motor drives an eccentric worm pump which transfers oil from the collecting trough to any of the five slop tanks. Two hydraulic cylinders in the pump system control the height of the bow skimming trough. Four ballast tanks permit trimming of the vessel to suit conditions of oil load.

All controls are located centrally permitting one man operation.

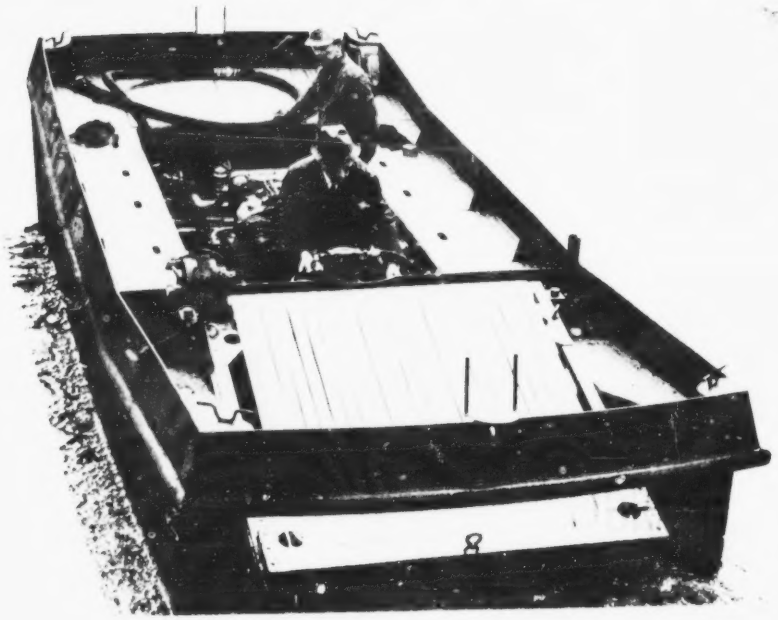
Depending upon the gravity and thickness of the surface oil layer, the vessel has an oil skimming capacity of up to 2245 gallons-per-hour. The belt skimmer is protected by patent.

The method of removal is by means of a number of endless belts driven around two rollers. One roller is immersed in the oil covered water and the other

is mounted on the barge so that the floating oil is transferred from the water into the barge on the surface of the belts.

The cost of a 25 foot unit is $35,000 and is supplied by:

Harmstorf Corporation
446 West 34 Street
New York, New York 10001



FICURE 13 HARMSTORF SKIMMER

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Sales Bulletin - Harmstorf Corporation, 446 West 34 Street, New York, New York 10001.

## MUTTON CLOTH ROLL SKIMMER

(Belt Type)

This skimmer was conceived by Oswald Hardie, Chief Engineer, Port of Manchester, England, and uses a mutton cloth belt to pick up oil, but it is a non-recycling system so presumably, the mutton cloth is continuously discarded.

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Study of Equipment and Methods for Removing Oil from Harbor Waters, August 25, 1969. Battelle Memorial Institute, Pacific Northwest Labs for Naval Civil Engineering Lab, Port Hueneme, California.

## OIL-EVATOR

(Belt Type)

The Bennett International Company is the distributor of a device called the oil-evator. This device was developed by the Canadian government and was used in the Vancouver area. In operation, oil is recovered by a conveyor belt rated at 43,000 gallons per day. The belt will retrieve oily petroleum and leaves the sea water behind. The device weighs less than 12,000 pounds.

Oil can be recaptured from the device in numerous ways, such as in a plastic containment bag, a barge or pump from a self-contained reservoir onto a tanker. The oil-evator under testing recovered 98% of the crude oil during medium ocean swell conditions.

Specific data as to type of belt material and removal mechanism of the oil from the belt is not readily available. Additional information on the oil-evator can be obtained from:

Bennett International Services, Inc.
320 A-5645 Topanga Canyon Blvd.
Woodland Hills, California 91364

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Brochure prepared by Bennett International Company, undated.

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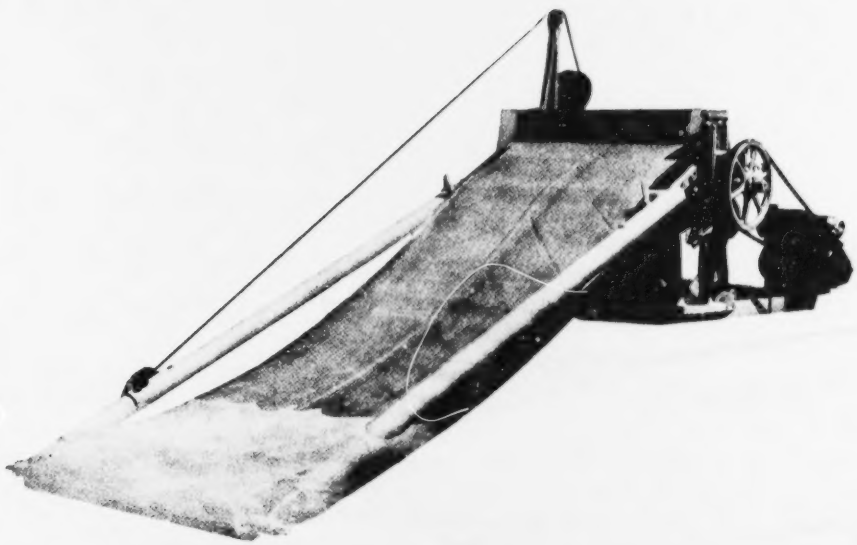

FIGURE 14 OIL-EVATOR

## REX CHAINBELT INC. SKIMMER

(Belt Type)

This oil belt skimmer consists of an endless conveyor belt running over a lagged, crown faced 12" diameter head pulley assembly. This assembly includes a #14 galvanized housing with a hinged access section and an intermediate section as required to meet discharge height requirements. The housing is anchored to the floor.

The endless belt can be either 12" or 24" wide, three ply oil service Buna-N with vulcanized splice and nylon filled fabric. Two side guide idlers, directly mounted on the housing are included. The belt can be removed by unbolting and removing the upper housing only. The skimmer also includes two non-sparking wear resistant doctor blades and two collection troughs to convey the oil to a common collection point. The skimmer is driven by a motor not less than 1/2 horsepower.

This skimmer is available from Rex Chainbelt Inc., Milwaukee, Wisconsin 53201.

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Product Data Sheet - Rex Chainbelt, Inc., Milwaukee, Wisconsin 53201, September 1966.

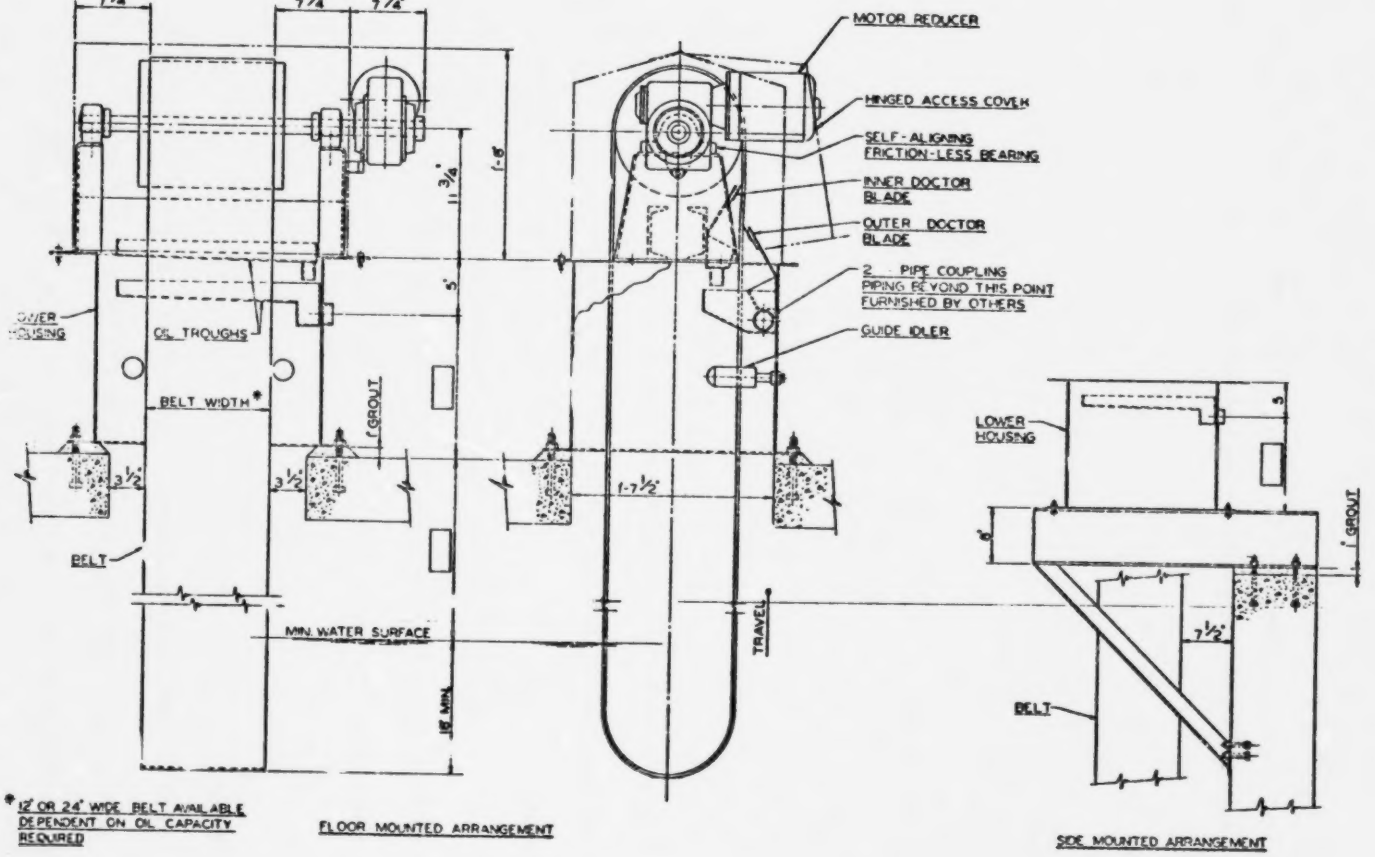


FIGURE 15 REX CHAINBELT INC. SKIMMER

## SELECTIVE SEPARATION OF OIL FROM WATER

(Belt Type)

The invention is concerned with a method of separating normally liquid hydrocarbon compounds from a liquid of higher specific gravity. It will selectively recover oil from a liquid of higher specific gravity such as water. U. S. Patent #3,146,192 has been assigned to Esso Research & Engineering Company.

This objective of the selective separation is accomplished by passing a polymeric film over the surface of the water and thus removing the oil from the water onto the film by means of the surface attraction between the film and the oil. Polymeric films which are suitable for use in this device are polyethylene or polypropylene sheets, or mixtures thereof. It has been found that a strong surface attraction exists between polyethylene and polypropylene films and normally, liquid hydrocarbon compounds. That is, by passing a film over the surface of water on which there are liquid hydrocarbon compounds, the hydrocarbon compounds are selectively attracted to the sheet or film in preference to the water and are thus removed to the surface of the water.

Additional information on this patent can be obtained from:

Esso Research & Engineering Company
Florham Park, New Jersey 07932

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U. S. Patent #3,146,192, dated January 24, 1962, issued to J. H. McClintock, assignor to Esso Research & Engineering Company.

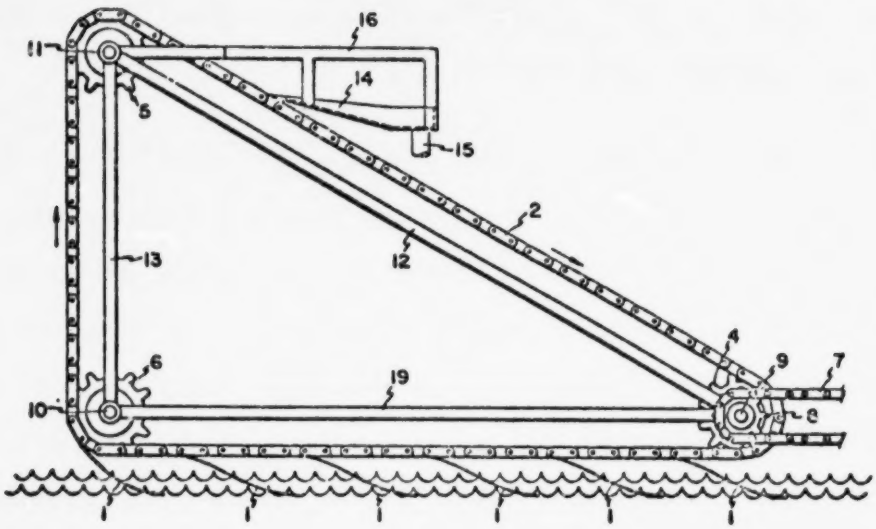


FIGURE 16 SELECTIVE SEPARATION OF OIL FROM WATER

## SEWELL BELT SKIMMER - CANADA

This device is covered by Canadian Patent #735,254, issued May 31, 1966. The invention is concerned with the physical removal of a spilled liquid from a body of water by means of an absorbent belt, which on being brought into contact with the spilled liquid and the body of water, absorbs the spilled liquid in preference to water. It has been discovered that an absorbent material satisfactory for this purpose consists of one which contains a high percentage of cotton. Richard Sewell has determined that dry cotton will absorb about 29 times its weight in bunker oil and cotton, which was soaked in water and subsequently wrung out. The cotton will soak up to approximately 21 times its weight in oil on being dipped into the oil only once.

Various mechanical arrangements can be utilized for the purpose of passing the selectively absorbent material into the spill, drawing the soaked material out of the spill and recovering the oil by subjecting the material to pressure.

The accompanying figure shows schematically one such apparatus.

An endless oil collecting belt formed of suitable material such as loosely woven absorbent cotton is threaded about the idler rollers so as to pass between them and the trough and between the powered rollers.

In operation, the powered rollers are rotated so as to cause movement of the belt and the roller support is lowered so as to bring the belt into

contact with the oil spill. As the belt rotates, it selectively absorbs oil from the water surface, carries it over the various rollers and to the powered squeeze rollers where most of the oil is removed from the belt and it runs off via the trough.

In this manner, continuous mechanical collection of the oil spill occurs and if the spill is large, the apparatus can be slowly moved through it by moving the barge.

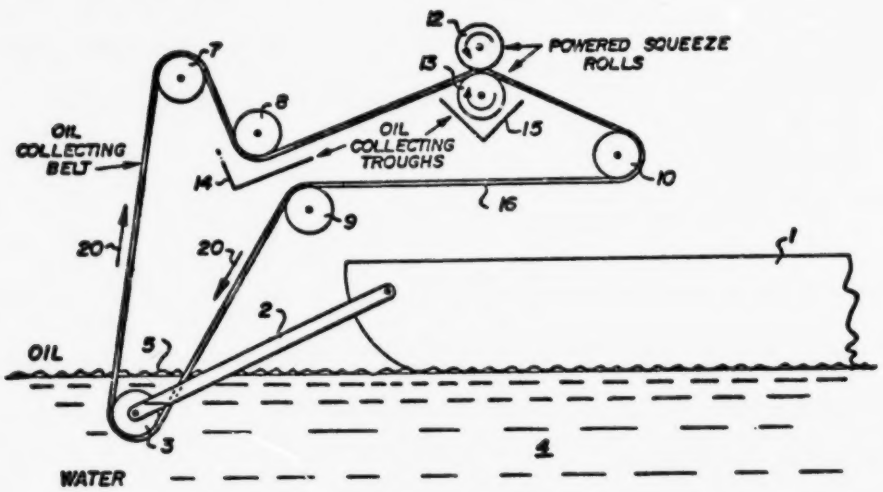


FIGURE 17 SEWELL BELT SKIMMER

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Canadian Patent #735,254, issued May 31, 1966, to Richard B. H. Sewell, Victoria, British Columbia, Canada.

## THE MURPHY PACIFIC MARINE SALVAGE COMPANY SKIMMER

(Belt Type)

On September 10, 1969, the Murphy Pacific Marine Salvage Company demonstrated a mechanical method of retrieving oil from a water surface at the Navy Base Port Service Dock area. The process reportedly developed by Shell Oil Company consists of an endless oil absorbent flexible floating vessel carrying a wringer unit which squeezes the belt to remove, collect and separate an oil and water mixture. This skimmer utilizes long, narrow belts with widths approximately 4-6 inches. The belts used are made of polyprcpylene. The device built to squeeze oil from the belt consists of two rubber covered rolls that both pull and compress the belt.

At a demonstration, the oil was dispensed on calm water and the moving belts were laid on the surface and threaded through the scrubbing device on the stern of an ICM boat. The demonstration showed that an oil scrubber process with a polypropylene belt has the capability to recover oil from a calm water surface. However, further development of the process under field conditions was recommended to be necessary before the feasibility can be firmly determined.

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Discussion of oil scrubber field trial of Murphy Pacific Marine Salvage Company. Skimmer at U. S. Navy Base, Treasure Island, San Francisco, California, on September 10, 1969. Bulletin is undated, but was received by FWQA on October 8, 1969.

## DESCRIPTION

## WEIR TYPE SKIMMERS

This type of skimmer removes oil from a mixture of oil and water by allowing the oil to overflow a weir into a collecting device and holding back the water against the weir. The height of the weir is usually adjustable by various means such as rate of pumping oil away, mechanical adjustment, etc., so that the thickness of the oil being skimmed from the water can be controlled. The weir can take on many configurations, smooth plate, saws teeth, circle, and many others.

The Standard Oil Company (New Jersey) reports that:

> "The operating conditions required for skimming vessels which recover oil by drawing it over a weir are similar to those for suction skimmers. Their efficiency is highly dependent on calm water and an adequate thickness of oil so that water intake is minimized; however, viscosity is much less important. Even under ideal conditions, a certain amount of water is drawn over the weir, thus making it necessary to provide a means for separating the oil and water.
>
> Various weir arrangements are used to collect spilled oil. Straight-edged weirs are usually used as the primary collector at the forward end of the skimming vessels. The oil and water mixture collected over the straight-edged weir then flows by gravity to a sump where the oil and water separate. A secondary weir is sometimes installed in the sump to skim the oil which has separated from water".

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Oil Spill Cleanup Manual, prepared by Oil Spill Task Force, Standard Oil Spill Task Force, Standard Oil Company (New Jersey), Logistics Department, 1969.

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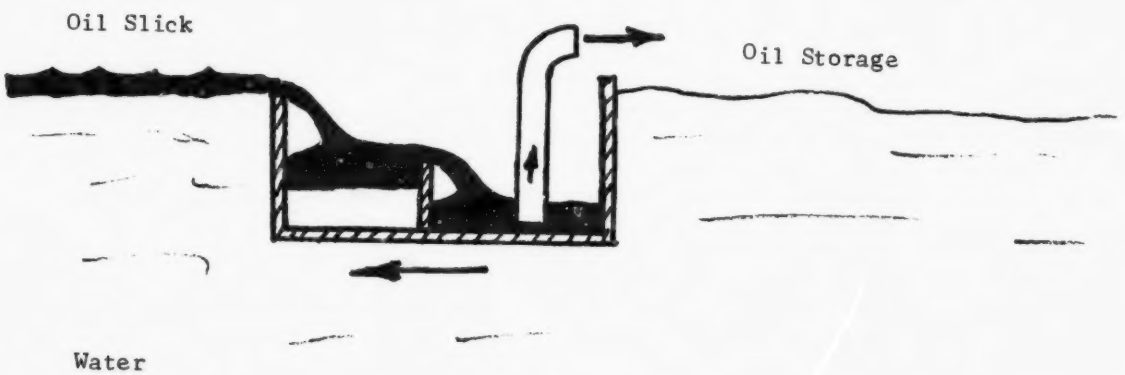
SCHEMATIC OF WEIR TYPE OIL SKIMMER



## DUNLOP-DRACONE SKIMMER

(Weir Type)

The Dunlop-Dracone Consortium has developed a system in their laboratories that reportedly offers an automatic oil and water separation device. This system is based upon the British invented Dracone barge. The flexible towable container is available for bulk liquid transport by sea, and reportedly will allow the continuous clearance of oil patches on the sea and inland waterways.

A special forward fitting to the Dracone barge employs a suction device, operated by a pump (either mounted on the towing vessel or raft) which skims the top few inches of the water - the depth of pick-up being adjustable. The oil and water mixture is pumped into the body of the barge where it rapidly separates. The length of the Dracone barge, up to 300 feet, assists almost complete separation of the oil and water. A discharge nozzle, weighted to the base inside the barge, allows the separated water to escape. Tests have shown that even with as little as 5% oil, the final separation is up to 90% effective. A towing vessel with a suction device and pump installed on it could carry empty rolled-up Dracone barges on deck. This system is being developed by the Dunlop-Dracone's Consortium, formed by Dunlop and the National Research and Development Corporation, and recent laboratory model tests have been

successful. It is expected that full-scale trials will be carried out in connection with some major oil companies in the near future.

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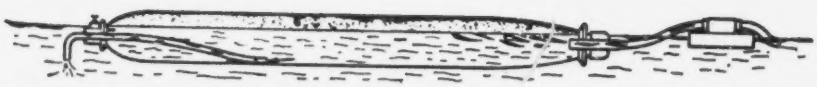
"Combating Oil Pollution", Petroleum Times, 71:620, 625-628, April 28, 1967.



*The Dracone oil/water separator barge. The oil/water mixture is sucked up by the pump at right (shown mounted on a raft). Separated oil forms a layer above the water, which is forced out of the discharge at left*

FIGURE 19 DUNLOP-DRACONE SKIMMER

## FLOATING OIL SKIMMER - GERMANY

(Weir Type)

The present invention covered by Patent #1,062,407, published March 22, 1967, consists of a method of removing liquid substances floating on the surface of water, particularly patches of oil. A flow to a bounded space is set up by means of a pump or pumps in the area of the water surface covered with the oil. This technique carries the oil floating at the top to the bounded space. The two flows are separated at the edge of the bounded space by a solid, separating member, having the form of a trough. The oil is removed by drawing off above the separating member.

Advantageously, the bounded space is formed by a body floating in the water.

In order to prevent water from being also drawn off to any great extent from the bounded space, a feature of the invention provides that the water level is first lowered inside the space bounded by the floating body by means of a water pump and the oil. It is then collected within the edge of the floating body in the bounded space and is removed by a second pump.

This system is now in production and is marketed by C. A. Bekhor Ltd., 29 St. James Street, London, England, S.W.1. The largest available unit has a suction capacity of 10 tons per hour and a 40 ton holding capacity.

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Patent Specification #1,062,407. Published March 22, 1967, issued to Rheinwerft Gesellschaft of Mainz-Mornbach, Germany.

"Rheinwerft's Answer to Oil Pollution", Becker, A., The Dock & Harbor Authority, Vol. L, No. 587, September 1969.

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*Photograph shews the 1,000 mm. diameter unit which is easily transportable to different locations and ideal for use by fire brigades. Pumps and motors can be placed on land or a boat.*

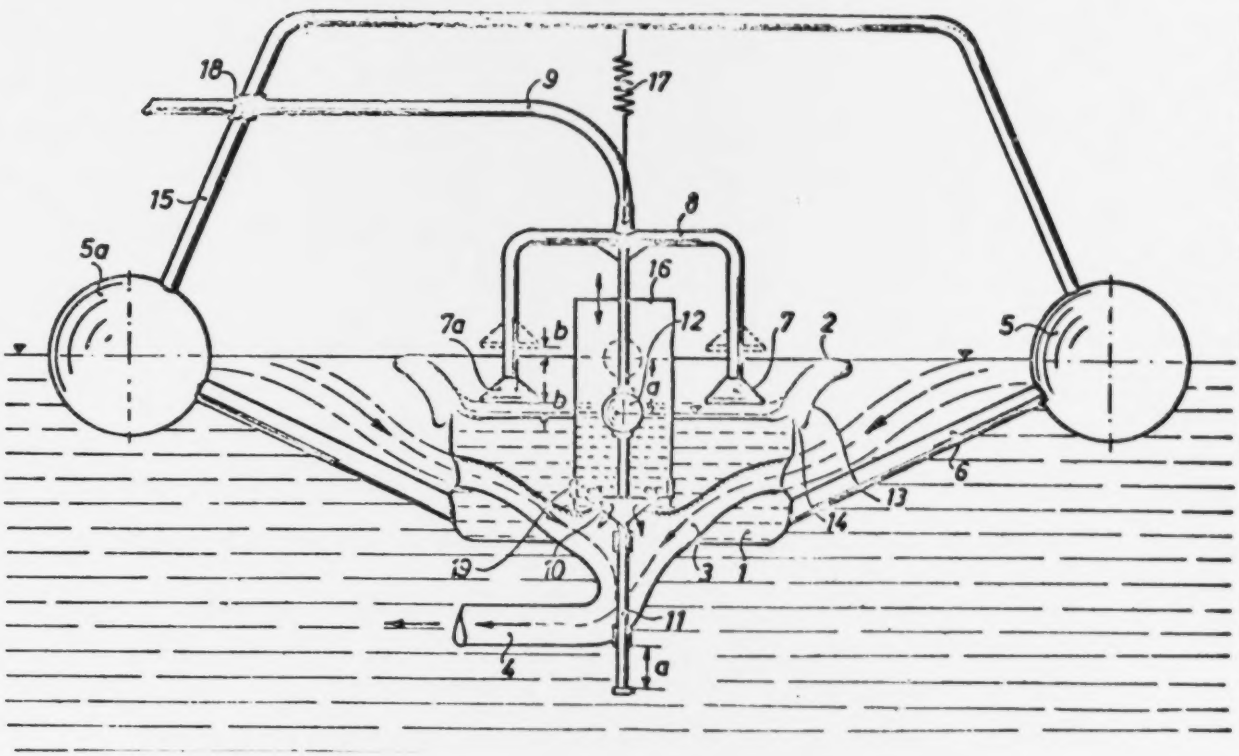


FIGURE 20 FLOATING OIL SKIMMER

## FLOATING SAUCER - WATER AND SLUDGE PUMP

(Weir Type)

This skimming device is simply a modified pumping system. This pump handles up to 42,000 gallons per hour and floats unattended. It pumps clean water, sludge, gravel or any solids encountered which will pass through the coarse screen and impeller - without damage. It is rugged, durable and light in weight. It is powered with a heavy duty 4-cycle gasoline engine, electric motor or air motor. The drivers can be interchanged easily in the field.

There is a fiberglass skimmer attachment which easily attaches to the pump body. By removal of the pump intake assembly the pump is converted into a skimming assembly for removal of oil or any liquid floating substance from the surface of the water. The adjustable inlet control covers can be set to allow skimming of a half-inch to three-inch depths on the surface of the water.

This equipment is available from International Marketing Agents, P. O. Box 95062, Oklahoma City, Oklahoma 73109, and is manufactured by Acme Products Incorporated, 8158 East 44th Street, Oklahoma City, Oklahoma 74145. The latest price quoted was $583.51 for the pump and skimmer attachment. The driver, depending upon the type of gasoline, electric or air, will add between $141.12 and $219.00.

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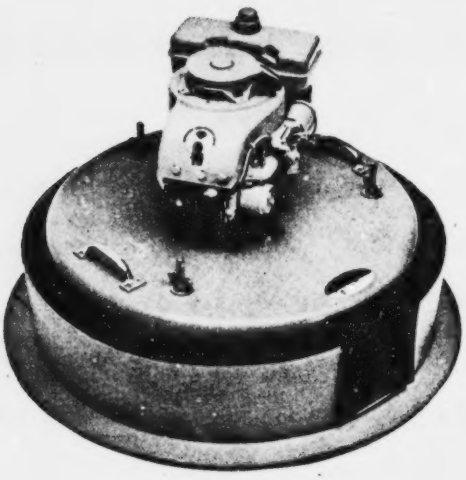
Sales Bulletin - Acme Products - International Marketing Agents, MIMCO, P. O. Box 95062, Oklahoma City, Oklahoma 73109.



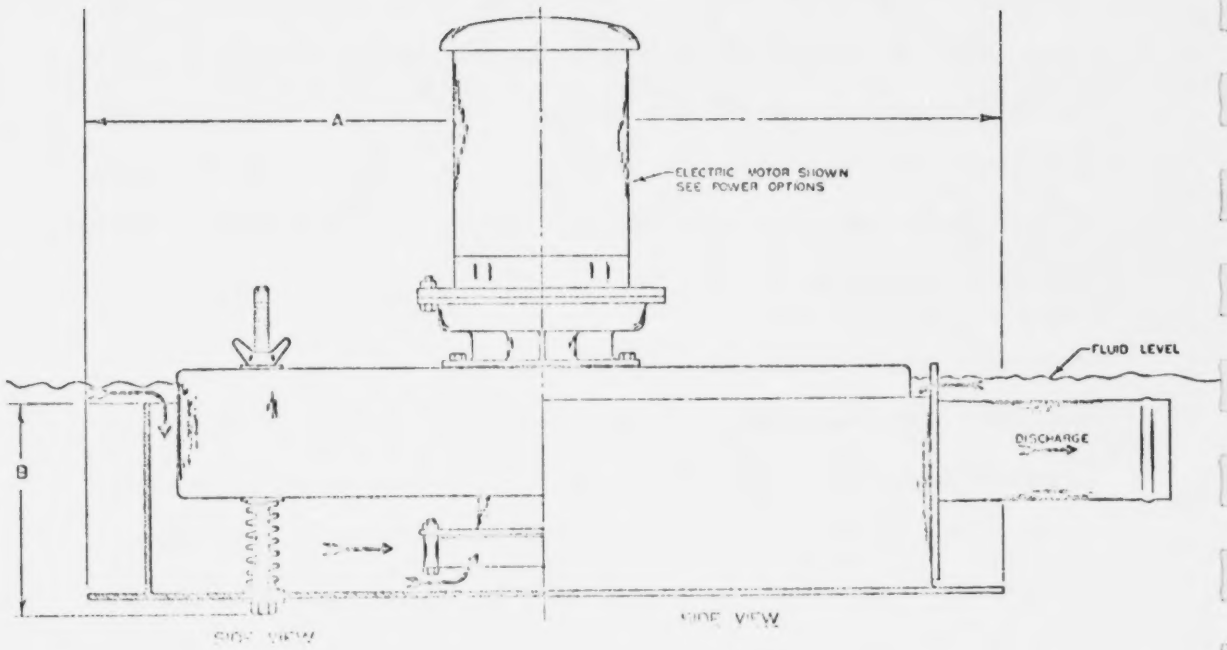



FIGURE 20 FLOATING SAUCER - WATER AND SLUDGE PUMP

## FUTABA

(Weir Type)

This weir type skimmer is manufactured by Hikari Industries Corp., Japan, and is installed on a catamaran 26' long and 13' wide. The weir is controllable. The equipment uses an open bottom settling tank to separate the oil and water mixture. As the oil reaches a certain level, it flows into a second of several successive settling tanks, each with bottom drains. The oil is concentrated in the last settling tank.

---

Letter from Maritime Safety Agency, Tokyo, to Vice Admiral P. E. Trimble, U. S. Coast Guard, March 29, 1968. Referenced in Combating Pollution Created by Oil Spills, Report to the Department of Transportation, U. S. Coast Guard, by Arthur D. Little, Inc.

## LIQUID SURFACE SKIMMING DEVICE

(Weir Type)

This skimmer is an apparatus for the recovery of a liquid floating on the surface of a heavier liquid. It is comprised of a combination of a suction hose having one end connected to a nozzle and adapted to a float. The nozzle is above and directed downwardly toward the upper surface of the floating liquid. A cyclone separator is connected to the other end of the hose. In addition, a separator tank is connected to the cyclone separator as a means for extracting air from the cyclone separator. The end of the suction hose connected to the nozzle is adapted to float with the nozzle between 1 1/2 inches and 1/4 inch from the upper surface of the floating liquid.

This equipment is described in a patent memorandum and has been patented by Esso Research and Engineering Company as of June 3, 1964.

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Patent Specification #959,484. Issued to David Watt. Assignor, Esso Research and Engineering Company. Published June 3, 1964.

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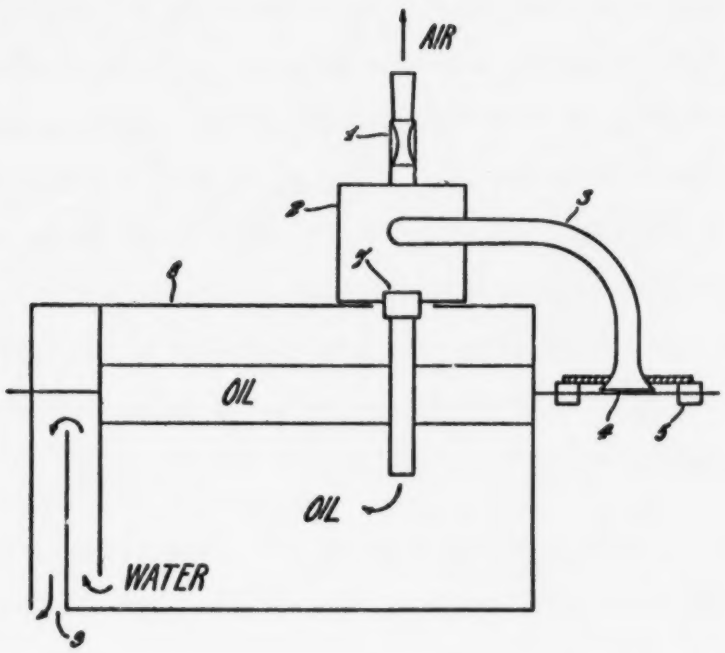


FIGURE 22 LIQUID SURFACE SKIMMING DEVICE

## NORFOLK SKIMMER

(Weir Type)

Oil is skimmed by special apparatus from a box-shaped barge known as the Norfolk Skimmer. This skimming device was used by the U. S. Navy at Norfolk, Virginia. The skimmer barge is 12 feet wide, 25 feet long, 8 feet 2 inches deep, and has large holes in the bottom for the free passage of water. The top part of the barge consists of air or flotation cells 2 feet 10 inches deep which support the skimmer at approximately 18 inches freeboard. The tank section of the barge extends 5 feet 4 inches below the air cells and has a capacity of 10,000 gallons.

Under the air-cell section of this skimmer, there is a small diffusion box with numerous holes into which the surface oil and water are pumped and from which they flow with little turbulence into the barge. Here, the oil and water are separated by gravity. The water passes out through the bottom and the oil remains in the barge. A metal sump, triangular in shape, is fitted to one end of the barge at water level. At the open end of the sump is a dam, the top of which is seven inches above the bottom of the sump. A trash screen rests on the dam. Since the sump can be raised or lowered on the barge, the top of the dam can be adjusted to a point a little lower than the water level. In the bottom of the sump is a six inch connection pipe that leads to a centrifugal pump on the deck of the barge. The pump draws the oil and water

over the dam into the sump and down through the diffusion chamber into the main compartment of the barge.

The pump operates at 65,000 gallons-per-hour and it can draw the oil and water continuously at this rate without changing the water line of the barge because of the large holes in the bottom. In this way, the skimming operation can continue until the barge is completely filled with oil. For example, in a recent removal, the oil slick measured 1,525 gallons. This particular oil slick was removed in 2 1/2 hours, or at the rate of 600 gallons an hour. The cost of removing this amount of slick was around 1 1/2¢ a gallon.

The large 65,000 gallons-per-hour flow of liquid over the dam creates surface movement of the oil and water. Thus, the concerted action results in withdrawing the slick from tight spaces. To induce movement from greater distances, a fire hose or work-boat propellers are used.

The Norfolk Skimmer costs approximately $10,000.

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"Removing Hazardous Oil Slicks at Norfolk", Lee, H. W., Naval Ship Systems Command Technical News, Vol. 5, p. 39-41, August 1956.

## PERFORATED BAFFLE SKIMMER

(Weir Type)

The apparatus is described in detail in patent application issued in Canada #682,305, dated April 5, 1961, and concerns improvements for separating liquids of different specific gravities; for example, oil and water, or mixtures thereof.

This device for separating mixtures of liquids having different specific gravities comprises an outer casing having an inlet for the mixture to be separated. A first outlet for the lighter liquid is located above the inlet. A second inlet for a heavier liquid and a perforated baffle partition or guide is located in the flow path between the inlet and the outlet. The perforations in the baffle are so formed as to present edges or teeth projecting from the surface from the baffle into the flow path so as to render the flow path through the baffle more tortuous.

The sheet elements for the perforated baffles may be produced by forming parallel rows of spaced slits. The slits are in adjacent rows but are in staggered relationship to each other. Alternatively, the perforated baffles may be formed by rough punching sheet material so as to form small holes with rough edges turned outwards. Suitable materials are ferrour and non-ferrous metals, or synthetic plastics such as polyvinyl chloride. According to this design, the liquid must double back on itself as it passes around the teeth and then into and through the

apertures. As a result of this change of direction, small globules of oil are intercepted by the edges or the teeth, and are prevented from passing with the streams of liquid through the apertures. As a result, the oil globules remain adhering to the edges or to the teeth until joined by further globules to form a small body of oil of sufficient buoyancy to overcome the adhesion of the baffle, whereupon the small body of oil floats upwards in the casing.

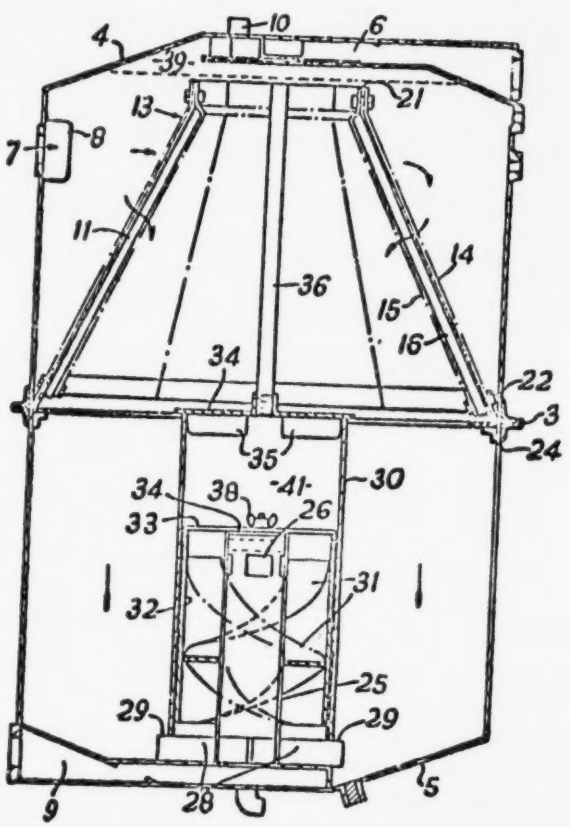


FIGURE 23 PERFORATED BAFFLE SKIMMER

Perforated Baffle Skimmer - Separation of liquids of different specific gravities - Canadian Patent #682,305, dated April 5, 1961.

## PIPE SKIMMER - CANADIAN PATENT

(Weir Type)

This device is described in Canadian Patent #691,710, filed January 3, 1962. It consists of apparatus for removing a surface layer of low density from a body of liquid of higher density. It is comprised of a flexible pipe or pipes surrounded by a layer of buoyant material and an outer sheath, whereby the flexible pipes float on the surface of the body of liquid. It has a number of suction nozzles connected to the flexible pipe, a filter for separating the surface liquid from the liquid of the body and a method of discharging the separated water back into the main body of water.

In operation, the pipeline is laid on the surface of the sea so that it surrounds the patch of oil which is to be removed. The suction nozzles dip into the surface layer and the oil with a certain amount of sea water is sucked into the pipe and then carried into the ship where it is forced through a filtering apparatus to separate the oil from the water. The oil is stored in the tanks of the ship, so that it may subsequently be used for its original purpose and the water is returned by a pressure pump to the pipe for discharging to the sea.

In addition, this patent application covers the provision of another pipe supported above and between the other pipes and a method (pump and piping) to supply liquid to this pipe in order to alter the buoyancy of the combination of pipes.

The patent application further covers additional equipment in the form of a vertical baffle supported on one side of the pipe at intervals to break waves and other disturbances in order to keep the surface layer in a calm state.

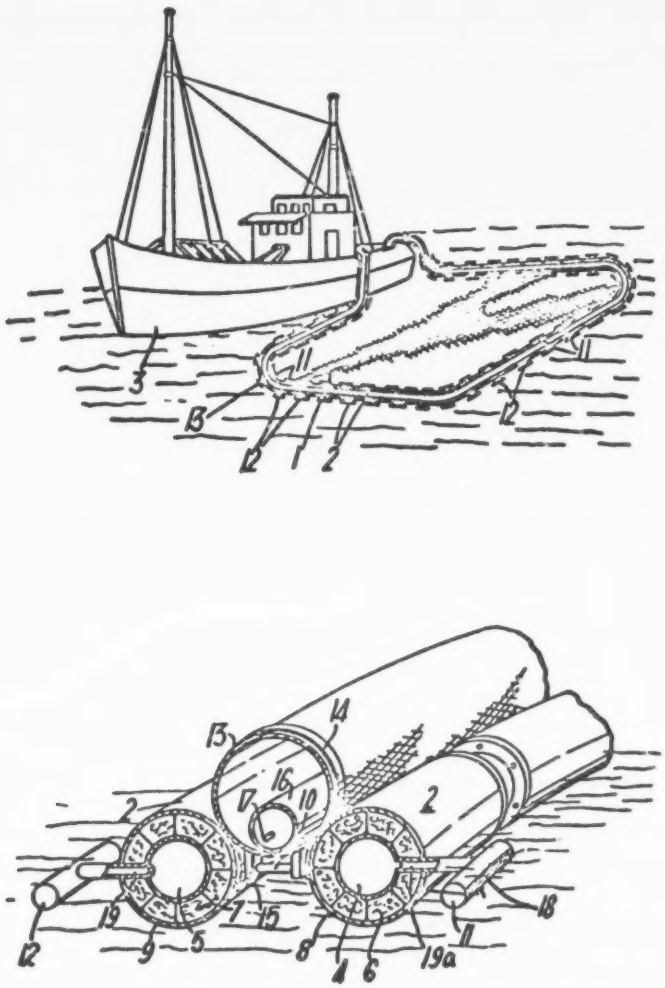


FIGURE 24 PIPE SKIMMER

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Canadian Patent #691,710, issued August 4, 1964 to Jacques Mueller, La Garenne, Colombes, France.

## SEA BROOM

(Weir Type)

The Sunshine Chemical Sea Broom is a combination pump with a fiberglass skimmer attachment. The system includes a 3 1/2" pump which is powered by a 3 hp, 4-cycle gasoline engine. A fiberglass skimming attachment, filled with urethane foam for maximum flotation, converts the pump into a skimming assembly.

Adjustable inlet control covers allow for skimming one-half inch to three inch depths on the surface of the water. The skimmed oil is pumped to tanks, trucks or pits.

Further information on the Sea Broom can be obtained from:

Sunshine Chemical Company
Main Office
P.O. Box 5534
Jacksonville, Florida 32207

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Sales Bulletin - Sunshine Chemical Sea Broom, P. O. Box 5534, Jacksonville, Florida 32207, obtained in December 1969.

## SEA SWEEP

(Weir Type)

This is an oil skimming system under development by Sea Sweep, Inc. and Core Laboratories, Inc. A single tugboat pulls a barge, and the skimming device is attached to the barge. The barge is equipped with pumps and storage facilities for the recovered oil. The skimming device is attached to the barge by means of a harness mechanism similar to that used in trawl fishing.

The skimming device is a tapered, flattened funnel assembly of wide-spaced net material, having a cover or top surface of flexible sheet material such as plastic or canvas which is substantially impermeable to oil. The tapered shape of the collecting unit channels the oil toward the back and to a collecting sump at the apex of the funnel. The sump is provided with a bottom panel of wide-spaced netting to permit the water to move freely underneath and out of the sump. The sump is divided into partitioned sections to permit pumping off of the oil with a minimum amount of water. The oil is pumped through plastic lines to storage tanks in the barge.

Widths of the skimming device up to 200 feet are claimed to be feasible. If the assembly is towed at a speed of two knots per hour with a funnel opening of 200 feet and with an oil film of 0.1", the volume of trapped oil will theoretically be 3600 barrels per hour.



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Further information can be obtained from:

Core Laboratories
P. O. Box 10185
Dallas, Texas 75207

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News Release obtained in December 1969 from Lenen and Newell, Inc., Wyatt and Williams Division, 19th Floor, LTV Tower, Dallas, Texas 75201.

FIGURE A

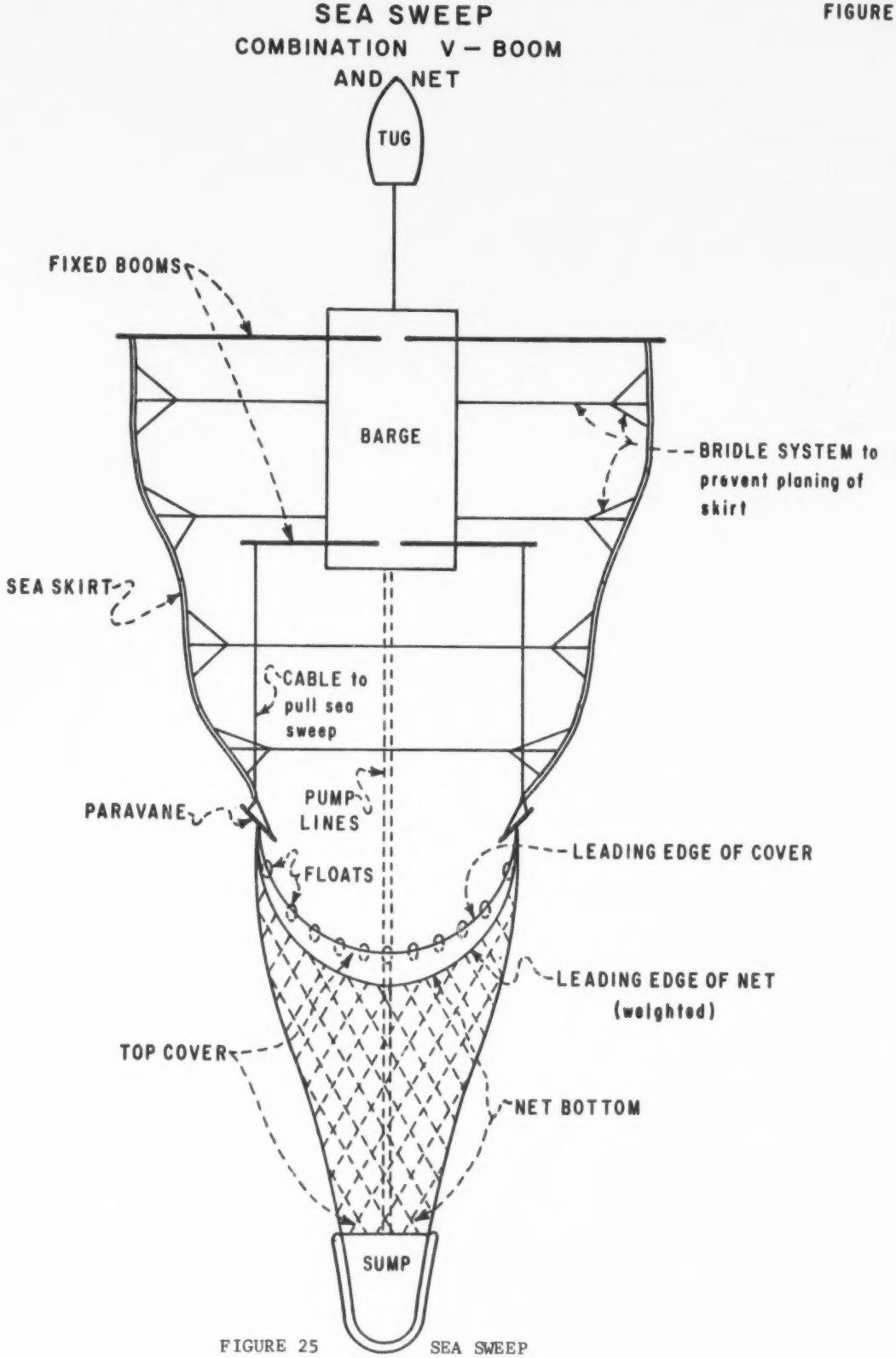


FIGURE 25 SEA SWEEP

## SKIMMER FOR REMOVING OIL LAYERS FROM WATER SURFACES

(Weir Type)

This skimmer was developed by Schuback of Germany, Patent #3,237,774, March 1, 1966.

This invention relates to an apparatus for skimming oil layers from water surfaces and consists of a collecting tank connected to floats. To insure a reliable operation in case of waves, the invention provides apparatus for skimming oil layers from water surfaces. It comprises of two floats forming a channel in between, a collecting tank connected to the floats and suspended in the channel, and a bailer of shovel-like design provided on the collecting tank and directed toward one end of the channel.

A guiding channel for the collecting tank may be formed by the floats at the skimming side of the apparatus with the guiding channel becoming narrower toward the bailer.

A frame may be provided for mounting the collecting tank transversely to the direction of skimming, and the frame may be suspended between the floats on pins extending in the direction of skimming. The collecting tank may be provided adjacent to the bailer with a collecting receptacle which extends into the water.

The preferred line-up is to include a suction pipe connected to a pump,

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which is secured directly to the floats and extends into the collecting receptacle of the tank.

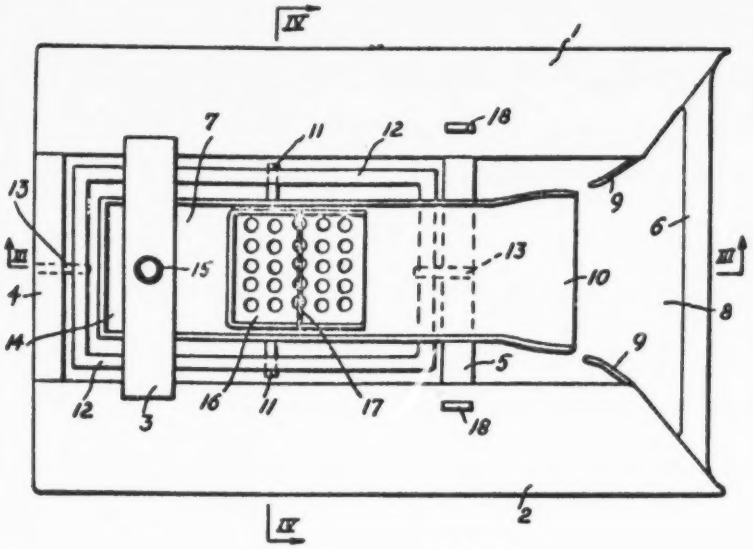


FIG.3

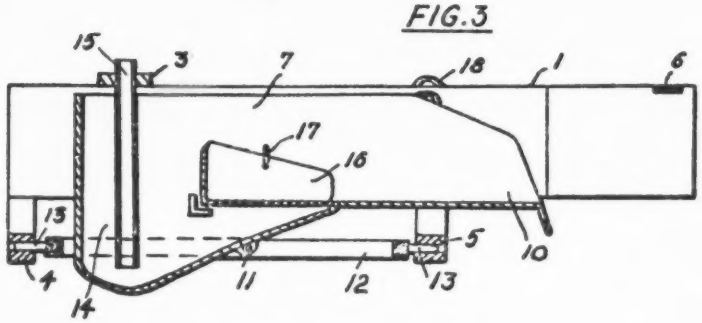


FIGURE 26 SCHUBACK SKIMMER CONCEPT

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U. S. Patent #3,237,774, dated March 1, 1966. Issued to Georg Schuback, Hamburg, Germany.

## TECHNOCEAN SKIMMER

(Weir Type)

The Technocean Company has completed a first series of small scale model tests for a pollution control ship, which is to be rather large (17,000 tons) and of a hybrid design. Forward, it will have a conventional single hull while the after half will have a catamaran twin hull.

The ship will move backward and skim the surface of the ocean taking in the variable thickness oil layer. A suction valve, 32 feet wide and of adjustable height, will be located at the forward end of the slot between the twin hulls. This positioning of the suction inlet is intended to overcome problems with use in open waters. The twin hull creates a sort of artificial harbor where waves and swell are claimed to be dampened significantly. According to specifications, the ship will be able to pump 2,640,000 gallons per hour, separate the oil, store it, either in its own tanks or in floating inflatable tanks towed nearby, and pump clean water to the ocean to achieve good maneuverability when moving astern. The on-board storage capacity is 50,000 barrels.

Each catamaran hull will have a steerable shrouded propeller. This pollution control ship will have a main screw for normal forward motion

immediately below the suction inlet. This screw will be useful in pollution control work as it will pump the mass of water pushed by the backward motion of the ship.

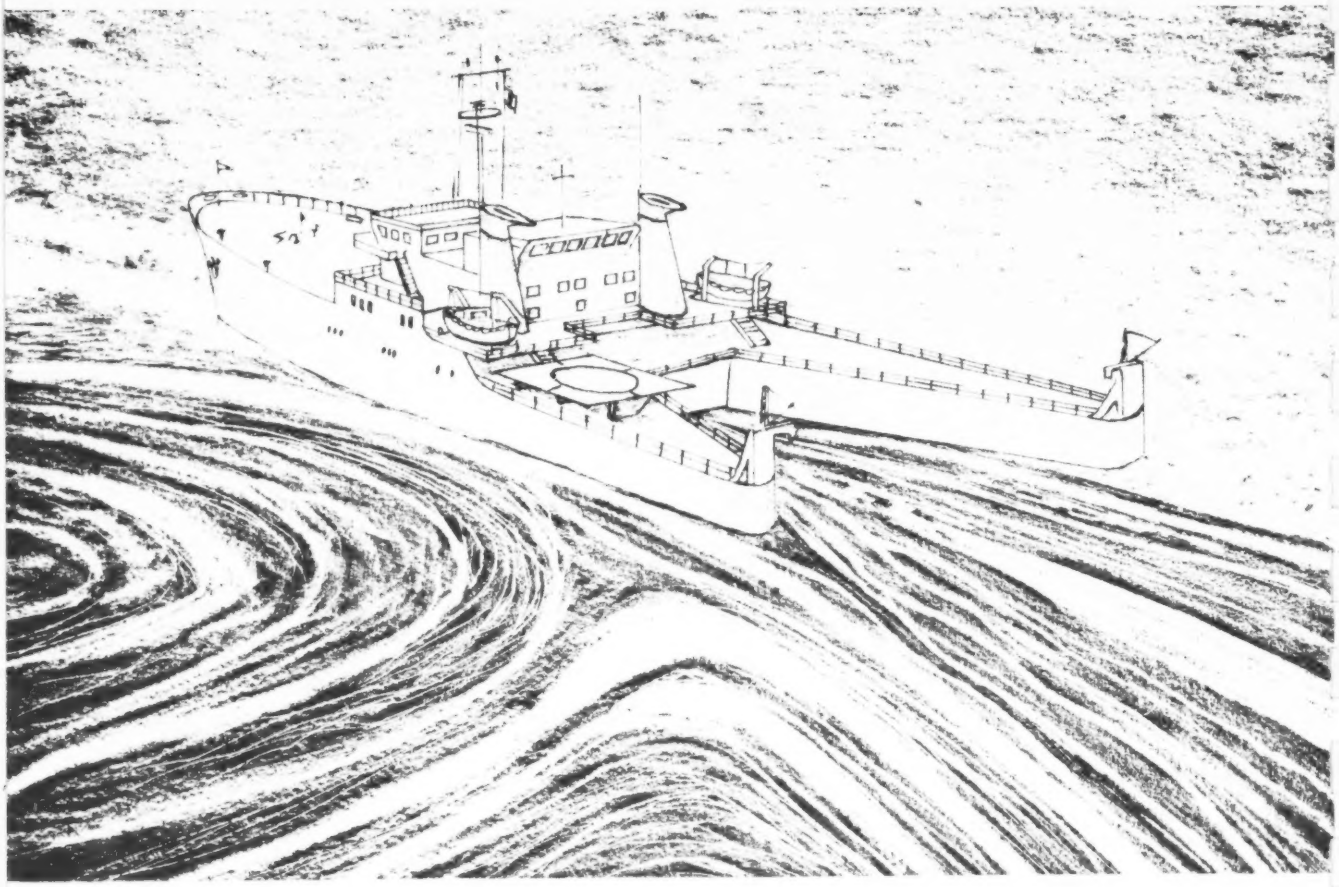

FIGURE 27 TECHNOCEAN SKIMMER

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Brochure supplied by Technocean, 45, Boulevard Haussman, 75 - Paris, France.

## "T-T" SKIMMER - NORWAY

(Weir Type)

This device skims oil spillage from the water surface and delivers it into a separator vessel which is maneuvered in the spillage area to sweep the water surface. The device consists of a seagoing vessel for separating liquids and materials of different densities from the surface of a body of water. It has a skimming board of spade form moved against the oil spillage so that the mixture, due to the relative movement, is guided aft into a chamber of the vessel. The bottom of this chamber is open and in contact with the water in which the vessel is in use to allow the water to escape and in the upper part of the chamber, oil is collected in an oil collector and later removed therefrom.

By means of this arrangement, the oil is concentrated in the chamber to such a degree that separation of the oil from the water may be obtained and reportedly only a small amount of water is in the collected oil when it is removed by pumping.

The vessel is designed as a barge with a flat bottom and square bow open along a portion thereof with the inclined skimming board disposed at the bow. The lower end of the skimming board and a front inclined portion of the bottom define a horizontal leading edge at a suitable depth under the water surface at the open bow portion.

According to a further development of the invention, it is possible to make the operation independent of the movement of the vessel. Accordingly, there is arranged over the inclined skimming board, means to urge the flow of water with lesser density contaminants over the skimming board and paddle wheel. The paddles of the wheel reach down in the water and will, when rotated, move the oil and water mixture over the read edge (weir crest) of the skimming board independently of the movement of the vessel. The barge is powered by an outboard motor, and paravans can be used to assist in directing the oil to the paddle wheel.

This equipment can be pruchased from the East Coast Services, Inc., Braintree, Mass. The commercial unit has a capacity of 1390 gallons-per-hour of oil recovered. It weighs 3500 pounds and costs $17,000.

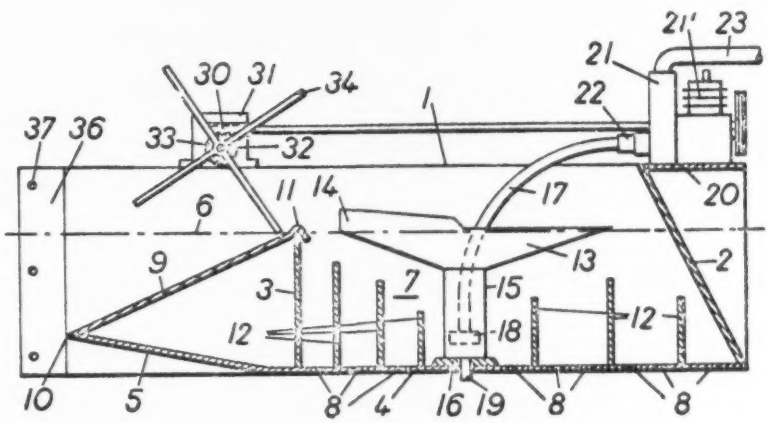


FIGURE 28 "T-T" SKIMMER

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Patent #3,219,190. Issued to Trygve Thune, Oslo, Norway, patented November 23, 1965.

## UNIVAC PUMP SKIMMER

Henry Sykes Ltd. of London, England has investigated the use of a Univac Pump Skimmer for oil pollution control. The Univac pump skimmer works with horizontally extended suction pipes out beyond the side of a tanker. These pipes terminate in a right angle bend and a length of flexible pipe. At the end of the flexible pipe is fitted a fan shaped suction entry of some three feet in length. The final design of the suction nozzle would be modified to meet a variety of conditions. Approximate calculation based on a vessel steaming at five knots and covering a 25 foot wide path, show that recovery rates could be in the order of 600 tons per hour of oil if the oil film were 1/2 inch thick.

The oil and water mixture would be pumped into the tanks of the coastal vessel and clear water would be extracted by arranging further pump suctions to draw water from a point near the base of the tank. This would allow the vessel to operate until the full cargo of oily sludge has been recovered.

The characteristics of Univac pumps are claimed to be particularly suitable for this type of work. They can operate with suction branches intermittently exposed to air and with suction lines up to 400 yards in length. They also have the ability to pass solid material up to four inches in diameter and thick sludges of high vescosity. They can handle

appreciable quantities of sand and gravel. At present, they are in use handling oil sludges during tank cleaning at terminals and refineries.

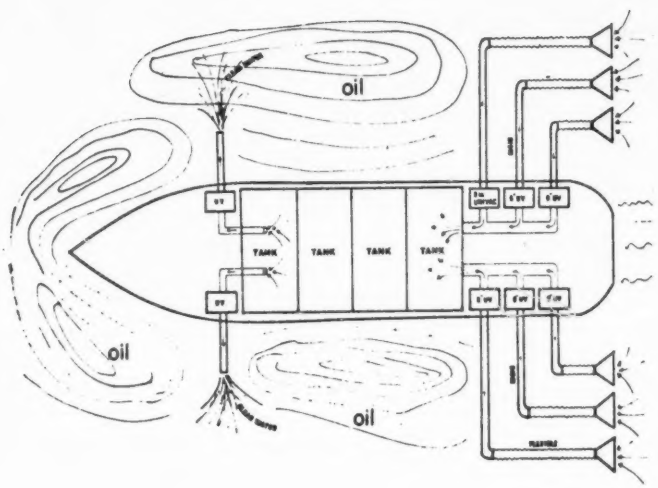


FIGURE 29 UNIVAC PUMP SKIMMER

"Combating Oil Pollution", Petroleum Times, 71:620, 625-628, April 28, 1967.

## VEROLME HARBOR CLEANER

The Rotterdam Netherlands Harbor is covered by a fleet of "harbor skimmers" constructed exclusively by the Verolme Shipyard Hensden, Ltd., of Rotterdam. They have operated this fleet for about ten years, have collected an average of 6000 tons of oil per year, and can collect 50 tons per hour - per unit.

The mixtures of oil and water are collected by a floating suction apparatus and go to a vacuum tank through hoses. The pump maintaining the vacuum tank will also forward the mixture to the first separating compartment wherein the separation of the oil mixture starts. For this purpose, the barge is divided into a number of closed hopper-shaped compartments. In the first compartment, a good deal of the oil will be separated from the water; it then flows into the next compartment where the separation is continued. As soon as the level in the separating compartments is above the outside level, the water automatically syphons overboard off the last compartment. The oil, in the meantime, flows into the wing storage tanks. The separation process thus proceeds automatically, simply regulating the flow, and since no mechanical energy is necessary, it is performed in an economical manner.

The inlet of the oily water, after having passed the vacuum tank, goes through a coaming in the deck of the barge; the oily water flows

through a grid into the first separating compartment. Because of the hopper-shape of the compartments, a great deal of the pollution is claimed to separate at once. The bottom of the hopper-shaped compartments form a rather narrow gutter; the baffles being fitted in the bulkheads at this point so that only the lower level of liquid flows from one compartment to the next. The collected oil, which may be disposed of as a valuable commercial product, is temporarily stored in the side storage tanks which also act as buoyancy tanks. These tanks provide stability for the barge and, at the same time, produce a greater freeboard, thus assisting the automatic discharge from the separating compartments.

The barge may be constructed either as a dumb or a self-propelled unit. The pump maintaining the vacuum in the vacuum tank which draws its mixture from the water surface is so mounted that it can unload the oil from the storage tanks and also be used for draining the separating compartments.

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Sales Bulletin - Verolme Shipyard Hensden Ltd., Verolme United Shipyards, Rotterdam, Netherlands.

## "WATERWISSER" SHELL OIL - NETHERLANDS

(Weir Type)

A prototype barge which skims the surface of the water over a large area and removes floating oil has been developed by Shell Oil Company engineers. The vessel named "Waterwisser" (water wiper) has been on trial in the docks of Rotterdam. It is equipped with a 50-horsepower diesel engine, is 46.9 feet long, 13 feet broad, with a draft of 4.9 feet. When moving through the water at 1.8 miles per hour, the barge skims a strip of water 65 feet wide with rigid booms hinged at the rear end of the vessel. In front of the hinge on each side and reaching 15.7 inches below the surface, there is an inlet slot through which the oil and water collected by the booms is sucked into the hold.

At this point where the boom is attached to the barge, the oil and water mixture enters the oil separation chamber via a vortex pipe. The submerged mouth of this pipe forms an open connection between the water inside and the water outside the barge.

After entering, the liquid flows through the hold, and the oil separates to the surface. The clean water beneath this layer is then pumped overboard.

Total oil capacity of the hold is 20 tons. The clean water pump, which is also used to remove the collected oil, has a capacity of 100 tons per hour. Driftwood and other floating objects are arrested by a grating and then dumped at a suitable location.

The barge is easy to navigate and when it moves backwards, the booms fold against the sides. They open again into a vee-position when the vessel moves forwards. Movement of the barge to the operating location is made with booms closed.

An operator can stand at the end of the booms and clean the embankments and harbor corners with a water jet and subsequently drive the oil between the booms. The embankments can usually be approached closely by the end of the booms since their draft is less than 10 inches.

The barge is manufactured by:

N. V. Bonn en Montage Bedrijf
Zwyndrecht, Netherlands

and

Holland Launch N. V.
Zaandam, Netherlands

The weight of the barge is about 20 tons.

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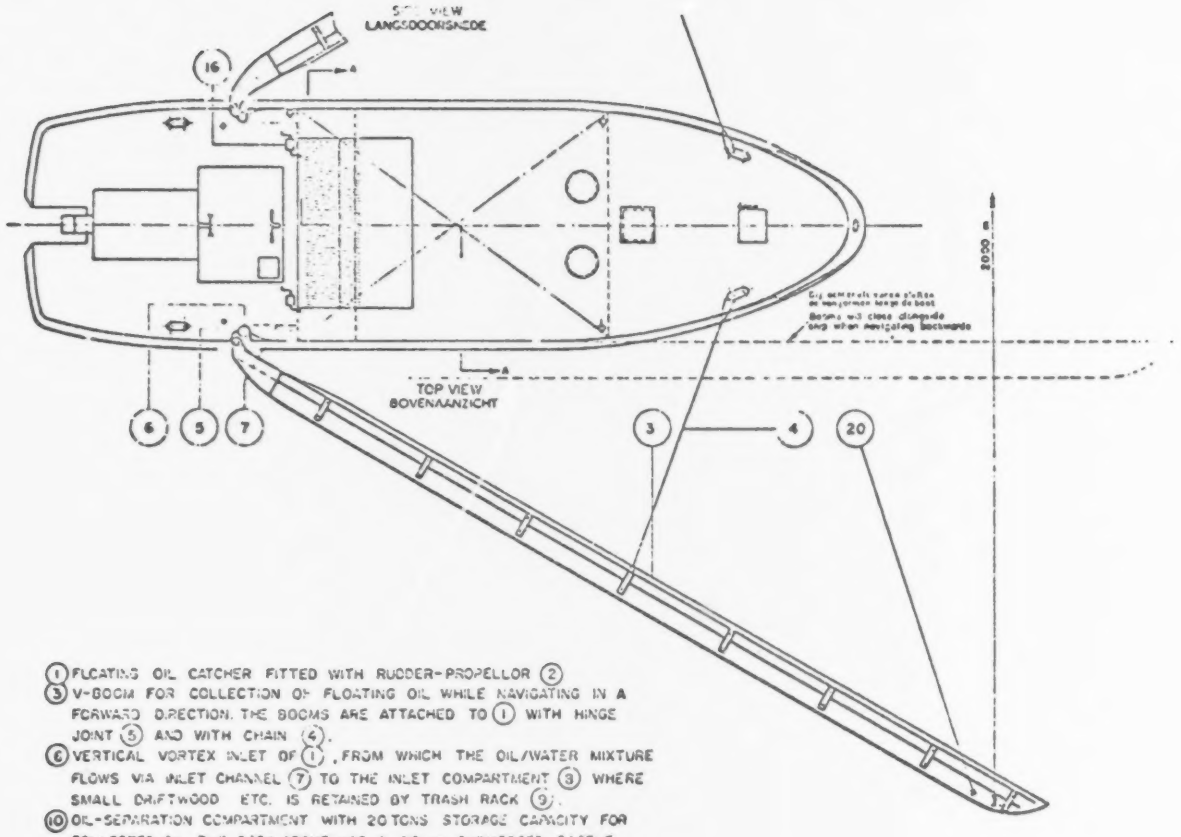
Sales Bulletin - from The Hague to Texas A and M University, Mr. B. R. Tyer, Department of Civil Engineering, College Station, Texas




(1) FLOATING OIL CATCHER FITTED WITH RUDDER-PROPELLOR (2)
(3) V-BOOM FOR COLLECTION OF FLOATING OIL WHILE NAVIGATING IN A FORWARD DIRECTION. THE BOOMS ARE ATTACHED TO (1) WITH HINGE JOINT (5) AND WITH CHAIN (4).
(6) VERTICAL VORTEX INLET OF (1), FROM WHICH THE OIL/WATER MIXTURE FLOWS VIA INLET CHANNEL (7) TO THE INLET COMPARTMENT (8) WHERE SMALL DRIFTWOOD ETC. IS RETAINED BY TRASH RACK (9).
(10) OIL-SEPARATION COMPARTMENT WITH 20 TONS STORAGE CAPACITY FOR COLLECTED OIL. THE DECK ABOVE HAS A 20 cm SUBMERGED BAFFLE AT THE INLET OF (10). THE AIR-TIGHT COMPARTMENT ABOVE THE LIQUID SURFACE IS PROVIDED WITH VENT (12) THAT CAN BE CLOSED WITH VALVE (13) IF A CONSTANT LIQUID LEVEL IN (10) IS DESIRED. EITHER WATER OR OIL IS DISCHARGED VIA TWO SWING PIPES (14), PROVIDED WITH INLET (15). THE POSITION OF THE SWING PIPES IS ADJUSTED WITH WINCH (16).
(17) PUMP DELIVERING 100 $m^3/h$. THROUGH DISCHARGE LINE (18) OR 60 $m^3/h$. AT 25 m HEAD TO OIL DISCHARGE LINE (19) OR HYDRANTS (20) TO WHICH A HOSE WITH FIRE NOZZLE CAN BE CONNECTED.

VEE BOOM SKIMMING BARGE

FIGURE 30 "WATERWISSER" SKIMMER

## MISCELLANEOUS OIL SKIMMING DEVICES

Included in the section are oil skimming devices that are either under patent or are utility type equipment which has been used to pick up oil from the water surface.

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## AIR BROOM - A PATENT

The air broom takes advantage of the known, but previously unused physical fact that the movement of oil on a body of water is substantially influenced by the direction of the air current flowing above it. This invention or patent proposes to sweep oil using a high volume stream of air or gas in order to: (1) protect critical areas from the invasion of floating oil; or (2) to collect the oil into a less dispersed mass to facilitate collection and disposal thereof.

The source of the air or gas could be any of several high volume gas moving devices, such as blowers or fans. The exhaust gas discharge from a jet engine similar to those used for aircraft and other motive power application appears to be ideally suited for this application. The air broom could be used in any of several applications where it may be desirable to move floating oil: (1) mounted on a vessel, the air broom could be shuttled back and forth along a side of an oil slick progressively sweeping the oil into a smaller area with each pass of the air broom; (2) mounted on a vessel, the air broom could be used in conjunction with a movable floating boom to move or convey the oil slick from a critical water area to a more suitable and less critical area for collection; and (3) the air broom could be mounted on shore and used to move oil carried by the current — such as oil floating on a river — to one side of the channel and into containment booms from which it could be collected and disposed.

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Patent information memorandum dated November 22, 1967, Hall, Radamacher, and Biglane, FWQA, Washington, D. C. 20242.

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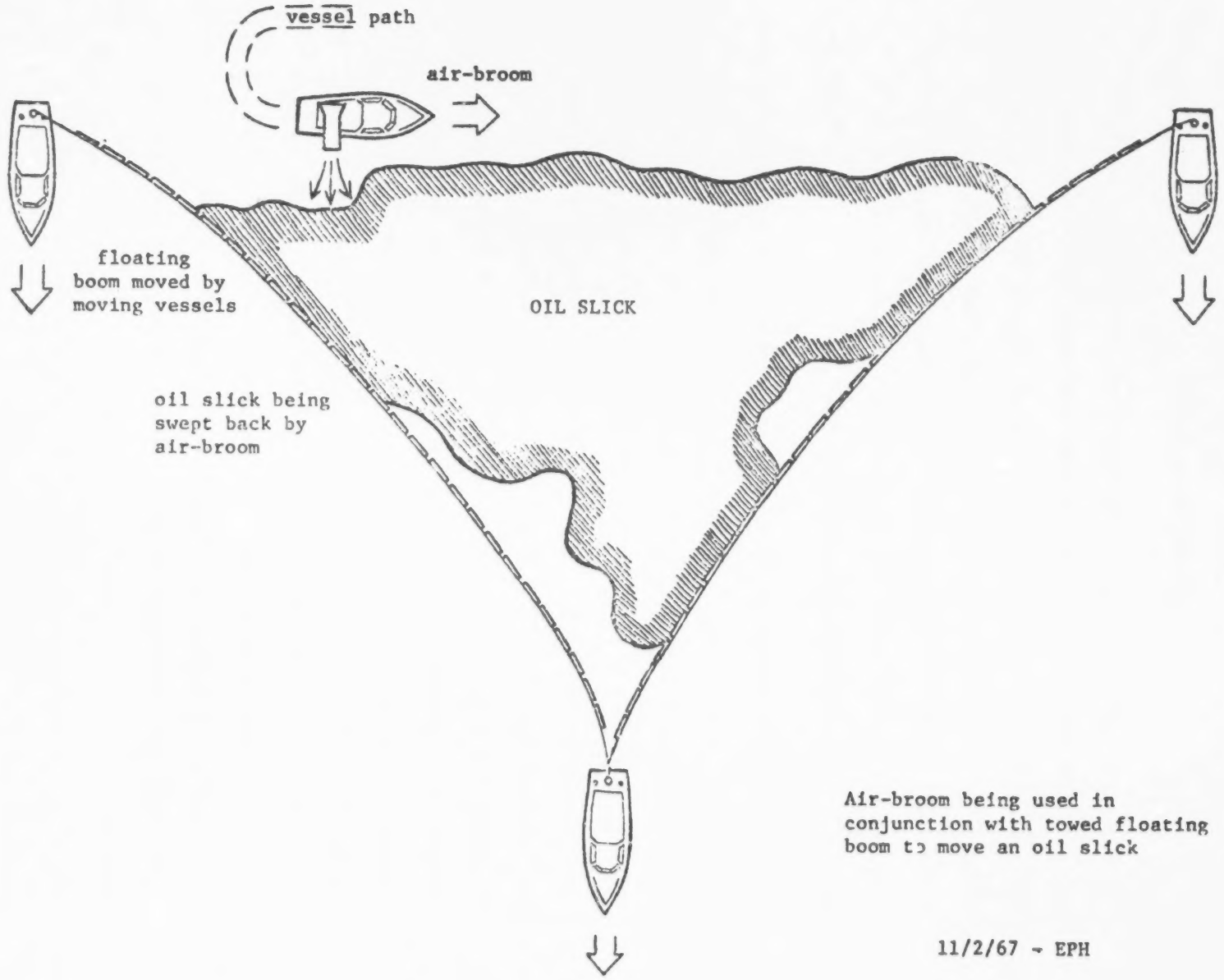


FIGURE 31 AIR BROOM

## BUDA-1 BARGE

The Marine Pollution Control Corporation has produced an anti-pollution barge, BUDA-1. It is a compact 40' x 10 1/2' vessel with a displacement of 24,000 lbs., so that it can be easily transported by truck, rail or air. BUDA-1 can pump 2500 gallons of spilled oil an hour when the surface depth is one inch and there is minimal debris. Two 25 foot suction hoses feed a four-tank separator system with a total capacity of 5600 gallons.

A hydraulically operated debris catcher is mounted at the bows. Further aft two 12 foot pivot outriggers swing from port and starboard. Powered by a 72 hp diesel engine, with bow propulsion for close maneuvering, the barge cruises at eight mph and can be operated by a two-man crew.

The BUDA-1 Barge is marketed by:

Marine Pollution Control Corporation
9010 Roselawn Avenue
Detroit, Michigan 48204

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Sales Bulletin obtained from the Marine Pollution Control Corporation, 9010 Roselawn Avenue, Detroit, Michigan 48204, December 1969.

FIGURE 32 BUDA-1 BARGE

## VACUUM TRUCKS

Vacuum trucks are used frequently in conjunction with weir type skimmers to remove oil from the surface of water. These trucks are constructed so that a vacuum can be developed on a tank located on a truck body by the use of a vacuum pump. The vacuum tank is connected to a weir type skimmer by a hose and the weir type skimmer is moved around in the oil and water mixture, or with thicker slicks the end of the vacuum hose itself is suspended just below the surface of the oil, in an inverted position, forming a weir. The oil is sucked through the weir type skimmer, and the hose to the vacuum tank on the truck. This operation is continued until the tank is nearly full. It is, of course, necessary to suck some water along with the oil to be certain that all the oil is withdrawn. With appropriate residence time the oil and water tend to separate by gravity, and the water can be drained off the bottom of the tank on site. Trucks can be operated in series to increase separation.

The truck, when filled, is removed to the location where the remianing oil and water mixture is to be handled and the mixture is disposed of via a pump.

Vacuum trucks are in considerable use because of their general availability and their mobility.

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Additional information may be obtained from most tank cleaning service companies.